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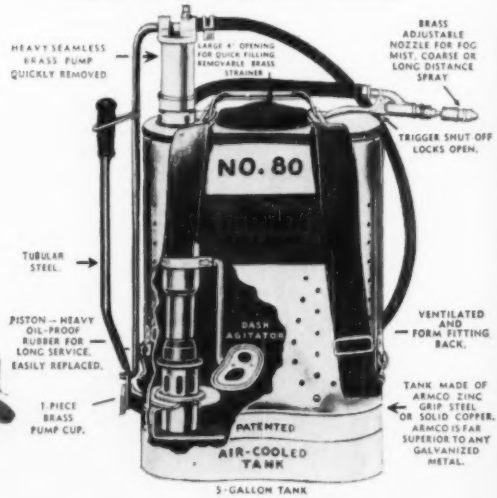
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Photo by Daniel O. Todd, U. S. Forest Service

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Journal of Forestry

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The Contribution of Remeasured Sample Plots to the Precision of Growth Estimates[1]

O. F. Hall

THE PAST DECADE has seen permanent sample plots, long the tool of the research forester exclusively, established over millions of acres of American forest land as a management tool of the production forester. This adaptation of continuous forest inventory, differing in a number of important respects from that developed in Europe, gives an estimate of past growth rate that is probably more accurate than that available with equal sampling intensity through other methods of growth measurement. Few direct comparisons are possible at present. It can be expected that the demand for accurate growth estimates will steadily increase as wood-using industries and the regions dependent upon them foresee a greater proportion of their future needs coming from timber yet to be grown rather than from timber already on the stump.

Many cost-conscious forest managers question the necessity of permanently establishing plots, when a series of temporary cruise plots, taken at less cost, would give just as good an inventory of current volume. Furthermore the forest manager may feel that a similar cruise with temporary plots at a later date will give another inventory of volume, and the difference between two two inventories would seem to give net growth. Unfortunately the sampling error of the growth figure obtained in this way is very large, including as it does the sampling error of both inventories. The difference figure representing growth is undependable; it contains not only sampling error of growth because less than the entire area was measured but also the difference that would be found between the two different samples without the intervening growth period.

With permanent plots the sampling error may be greatly reduced, in fact reduced so much that the growth figure is more precise than the volume inventory figures from which it is apparently derived. This anomalous situation, giving as it does a major advantage to permanent inventory plots, has been sensed by a number of foresters advocating the use of permanent plots for inventory, but the statistical explanation for it has not been given in forest mensuration textbooks or the current literature on forest inventory. As a result most literature on growth study and inventory tends to depreciate the use of permanent inventory plots, giving as reasons the difficulty of obtaining measurements of sufficient accuracy, the additional expense of permanently marking trees and plots, and the difficulties of handling the large amounts of data gathered. These difficulties have been minimized in recent years, largely through the work of C. B. Stott (*11*), who has developed methods of establishing permanent plots quickly and has demonstrated that with training and care the forester can make sufficiently accurate measurements of tree diameter to define small increments.

Two other reasons the great possible precision of growth measurements has not been recognized are: (1) the common use of the abbreviated equation for standard error of the difference in two means in many statistics and mensuration books, and (2) the practice of expressing standard errors in percentage rather than in absolute values. The influence of both of these practices will be discussed in detail later.

The objective of this article, then, is to show that, when permanent sample plots are remeasured for forest inventory, the precision of the resulting growth figure is much greater than when two series of temporary plots are used, and usually is greater than the precision of the estimate of standing volume. Here the term precision is used in the statistical sense, meaning "repeatability" or sampling error of the estimate (*4*). Precision is measured in terms of standard error of the average or standard error of the average difference. Precision is here distinguished from accuracy, which applies to the "trueness" of an average, a difference, or other estimate, and is determined by the correctness of measuring technique, the carefulness of the observer, and freedom from bias. Accuracy of a measurement can be appraised only when there are other measurement methods available against which the one in question may be checked.

This article is concerned with the

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[1]The author wishes to acknowledge the assistance of C. B. Stott, Region 9 office of the U. S. Forest Service, and John W. Hubbard, Minnesota and Ontario Paper Company, in obtaining the data for the examples in this article. Computations were carried out in the Purdue University Statistical Laboratory. This is published as Journal Paper No. 1374 of the Purdue Agric. Expt. Sta.

precision of growth estimates, rather than their accuracy, in the sense these terms are defined in the previous paragraph. It is recognized that the accuracy of measurement on permanent inventory plots is as subject to errors due to carelessness, poor technique, bias in sampling, etc., as are other growth and inventory measurement systems. However, the permanent sample plot method should be no more subject to these errors than other methods and does hold the advantage of possible reduction in growth sampling error described here. Also it may give more accurate records of ingrowth and mortality. The question of how much additional precision justifies greater expense must be left for additional research.

Review of Literature

A number of recognized textbooks and other references have been examined for assistance in explaining the calculation of sampling error on permanent growth plots. Some of these (*2, 3, 10*) devote very little space to the use of permanent sample plots for growth determination, describing them as principally useful in research studies, requiring too much effort for the information they give, and involving errors of measurement that are too great in comparison with the small growth differences. Davis (*6*) briefly mentions the method and even suggests in general terms the statistical basis for its precision. Meyer (*8*) describes continuous forest inventory in considerable detail, but he discusses only the system in which individual trees are not identified and the sampling error is calculated per tree rather than on an area basis. Meteer (*7*) and Cutler (*5*) give descriptions of specific inventories using permanent plots, but they make no mention of the statistical advantage of permanent plots or of the calculation of a statistical check. Cutler does reflect the common failure to recognize high precision in growth estimates from permanent plots by stating that other work than his has "indicated that about 12 times as many plots are required to sample growth as are necessary to sample sawtimber to the same degree of accuracy."

The statement that "remeasuring identical areas" is the best method of determining growth during a past period is made by Bickford (*1*), but he does not go into the reasons. He then shows that using individual-tree data for computing separate d.b.h.-growth trend lines for each species gives a more precise estimate of stand basal area growth than when these d.b.h.-growth relationships by species are not available from individual tree records. He also suggests a method of using cost information to ascertain whether individual-tree data, gathered, and used in this particular way, is justified.

Sampling Error of Growth

Growth, as a mathematical expression, is usually the difference between two measurements rather than a single measurement. The determination of the statistical precision of an average growth measurement is, therefore, a problem in the sampling error of a difference. The way in which this sampling error is estimated depends upon the way the average difference is calculated. If each average is taken separately and the difference determined by a single subtraction, the standard error of the average difference is calculated by the equation:[2]

$$s_{\bar{x}_1-\bar{x}_2}=\sqrt{s^2_{\bar{x}_1}+s^2_{\bar{x}_2}}=\sqrt{s_1^2/n_1+s_2^2/n_2} \quad (1)$$

(If pairing is to be posible, n_1 must $= n_2$.)

On the other hand if it is possible to logically associate one observation from the first sample with a particular observation of the second sample and so obtain a sample of n differences from which an average difference may be calculated, the standard error of the average difference is calculated by the equation:

$$s_{\bar{d}}=\sqrt{s_d^2/n} \quad (2)$$

The same value may also be calculated from the standard errors of the first and second samples by the equation:

$$s_{\bar{d}}=\sqrt{s^2_{\bar{x}_1}+s^2_{\bar{x}_2}-2r_{12}s_{\bar{x}_1}s_{\bar{x}_2}} \quad (3)$$

To use Equation 3 it is again necessary to be able to associate particular observations in order to calculate the correlation coefficient r.

Examination of Equation 3 shows why sampling is so much smaller if it is possible to pair observations from the two samples. If r is large, there is a great reduction in standard error. As r becomes smaller, the standard error becomes larger, equalling the standard error of unpaired samples when there is no correlation. Unfortunately all forest mensuration textbooks and many statistics books have found need for only the abbreviated form (Equation 1) so that the true significance of the entire equation in growth studies has not been readily seen. A complete derivation of Equation 3 is given in Section 7.10 of Snedecor (*9*).

In growth studies the permanent location of the plot makes it possible to pair the first and second measurements. The shorter the period between measurements, the higher will be the correlation between first and second measurements and, therefore, the greater the advantage of permanent plot. As the interval between measurements becomes longer, there is more time for variable growth rates, mortality, ingrowth, and cutting to exert their influence. Consequently the correlation will become smaller and the advantage of permanent plots decreases. More long term records on permanent plots are needed to show how long an interval must pass before permanent plots have no value, but it would seem to be quite a long period, perhaps 20 years or more. Naturally it will vary widely with growth rates, forest types, and management practices.

Woodlot Example

To illustrate how these calculation methods operate in specific inventories, two sets of inventory

[2] See Table 1 for the meanings of the symbols.

data have been analyzed to show the standard error of the growth estimate. The first example is Stone's Woods, a 55-acre woodlot near Milwaukee, Wisconsin, in which C. B. Stott of the U. S. Forest Service has remeasured 75 permanent 1/5-acre plots annually for a number of years. On these plots each tree is marked with a painted number, and the point of breast-high measurement of diameter is marked with paint. Diameter measurements have been carefully taken to the hundredth of an inch each year. The data used here are the plot volumes at the beginning and end of a nine-year period, 1945 to 1954. For maintaining simplicity of the explanation, the data have been kept on a plot basis rather than converted to per acre. Over the nine-year period there was cutting and some natural mortality, so some plots had a negative net growth.

Study of the data for the small woodlot in Table 1 will show that the average net growth per plot over the nine-year period was 166.8 board feet. If pairing is ignored, the standard error of the difference is calculated by Equation 1 to be 121.57 board feet. This is greater than the 83.76 and 88.12 standard errors for the plot volumes at the beginning and ending measurements. However, if the net growth is taken for each plot and the standard error of those values are calculated by Equation 2, a standard error of 33.26 board feet is obtained, only one-fourth the previously calculated value and much smaller than the sampling error of the volume estimates. Exactly the same value, 33.26 board feet, is obtained by substituting the appropriate values in Equation 3, as the reader may demonstrate to himself. This great reduction in sampling error is to be expected because of the high correlation coefficient, 0.926, between plot volumes from the two measurements.

Industrial Forest Example

The second example is one district of an industrial forest in northern Minnesota, a part of the ownership of the Minnesota and Ontario Paper Company. On this district of approximately 90,000 acres, 254 permanent 1/7-acre plots had been established and remeasured after three years. Volumes and growth on these plots are given in cords and do not include the relatively small number of sawlog-size trees on which volume was computed only in board feet. This example is especially interesting because, due to cutting and mortality, the average net growth on the plots is very small. The data is realistic in having a number of plots with no volume.

Table 1 gives the statistics for the growth on this area. The net growth per plot is only 0.012 cords. The standard error of this average growth is 0.123 cords if the possibility of pairing is ignored, but it is reduced to 0.031 cords if individual plot growth figures are used. Again it will be noticed that the sampling error of the growth measurement is smaller than the sampling error of volume.

Corrections for Finite Population

To keep the discussion as simple as possible the equation and calculations have been kept in terms that theoretically apply only to an infinite population of plots. When the total number of possible plots

TABLE 1.—SUMMARY OF SYMBOLS AND STATISTICS FOR TWO GROWTH STUDIES

Symbol	Descriptive terminology	Small woodlot	Large industrial forest
n	Number of plots	75	254
$\bar{x}_1$	Average volume per plot, 1st measurement	1457.7 bd. ft.	1.247 cords
$\bar{x}_2$	Average volume per plot, 2nd measurement	1624.5 bd. ft.	1.259 cords
$\bar{d}$	Average difference, or net growth per plot	166.8 bd. ft.	.012 cords
s_1	Standard deviation of plot volumes, 1st measurement.	725.4 bd. ft.	1.379 cords
s_2	Standard deviation of plot volumes, 2nd measurement.	763.1 bd. ft.	1.401 cords
s_d	Standard deviation of a sample of differences, or growth per plot.	288.0 bd. ft.	.497 cords
$s_{\bar{x}_1}$	Standard error of average volume per plot, 1st measurement. (infin. pop.)	83.76 bd. ft.	.086 cords
$s_{\bar{x}_2}$	Standard error of average volume per plot, 2nd measurement. (infin. pop.)	88.12 bd. ft.	.088 cords
$s_{\bar{x}_1 - \bar{x}_2}$	Standard error of the difference in the two average volumes (unpaired). (infin. pop.)	121.57 bd. ft.	.123 cords
$s_{\bar{d}}$	Standard error of a sample of differences, or of growth per plot. (infin. pop.)	33.26 bd. ft.	.031 cords
r_{12}	Correlation coefficient between plot volumes at 1st and 2nd measurements.	.926	.936
Σx^2_1	Sum of squares of volumes of individual plots at 1st measurement.	198,319,700.3	875.661866
Σx^2_2	Sum of squares of volumes of individual plots at 2nd measurement.	241,029,015.2	898.891589
Σd^2	Sum of squares of differences or growth on individual plots.	8,225,045.1	62.507203
$\Sigma x_1 x_2$	Sum of products of 1st and 2nd volume of individual plot.	215,561,835.2	856.023126
E	Limit of error on net growth.	39.88%	511.48%
$\%s_{\bar{x}_1}$	Standard error of average volume per plot as a percentage of the average volume. 1st measurement.	5.75%	6.93%
$\%s_{\bar{d}}$	Standard error of average net growth per plot as a percentage of average net growth.	19.94%	255.74%

TABLE 2.—STANDARD ERRORS OF WOODLOT INVENTORY CORRECTED FOR FINITE POPULATION

Symbol	Terminology	Standard error
		Bd. ft.
$s_{\bar{x}_1}$	Standard error of average volume per plot, 1st measurement.	71.57
$s_{\bar{x}_2}$	Standard error of average volume per plot, 2nd measurement.	75.29
$s_{\bar{x}_1 - \bar{x}_2}$	Standard error of the difference in the two average volumes (unpaired)	103.87
$s_{\bar{d}}$	Standard error of a sample of differences, or of growth per plot.	28.41

is limited, as in any actual inventory, a more correct standard error of estimate is obtained by the equation:

$$s_{\bar{d}} = \sqrt{s^2_d/n \left(\frac{N-n}{N-1}\right)} \qquad (4)$$

where: N = total number of possible plots.
n = number of plots in sample.

The area sampled on the industrial forest is so large that the correction for a finite population makes no material change in the calculated standard errors. The woodlot is small, however, and the standard errors are reduced by the correction. The corrected values are given in Table 2. Despite these corrections, the comparisons made between estimates of standard errors of growth and volume, and of paired and unpaired growth, remain the same.

Reduction in Required Number of Plots

The possibility of pairing through permanent plot location has, in these two inventories, reduced the standard error of the growth estimate to almost one-fourth its probable standard error with temporary plots. In the woodlot about 216 temporary plots, 2.8 times as many, would be needed to give precision to the growth estimate equal to that attained by 75 permanent plots. For the industrial forest 3,970 temporary plots, or about 15 times as many, would have to be taken to give equivalent precision.

The necessary sums of squares and products are given in Table 1 for use by anyone wishing to check the statistics given.

Limit of Error

It has been customary among some foresters to express the sampling variation of an inventory as twice the standard error and to express this as a percentage of the average. The resulting value has been termed *proportional limit of error* (*8*).

Foresters doing statistical checks on American continuous forest inventory in recent years have used for computing limit of error the following equation, developed by W. W. Barton (*12*) for making statistical checks on punch card machines:

$$E = 2\sqrt{\left(\frac{n\Sigma x^2}{(\Sigma x)^2} - 1\right)\frac{1}{n-1}} \qquad (5)$$

Applying this equation to the growth data for the woodlot, one obtains a limit of error of .3988, or 39.88 percent. This figure times the growth, 166.8 board feet, gives an estimated error of 66.52 board feet or twice the standard error of the other methods of calculation. Therefore, foresters using business machines and punched cards to do statistical checks of data from permanent inventory plots may use the same procedure for calculating the limit of error on their net growth estimates that they have been using on the limits of error of volume estimates. Growth is simply another characteristic of the plots, and its sampling error is calculated exactly as the sampling error of cordwood volume, sawlog volume, basal area, or any other observed or measured item. The same is true for gross growth, mortality, ingrowth, or any other component of net growth.

Dangers in Percentages

It may be that one of the reasons the relationships shown in this article and the advantages of permanent sample plots have not been more obvious is the practice of expressing standard errors as percentages of the average. A *percentage* standard error of an average growth figure may easily be greater than the *percentage* standard error of the first or second inventory used in the growth calculation, whereas *absolute* figures will show the reverse relationship. It is the old story of changing the base in the percentage. Percentage standard error of growth is based on the small growth figure, while percentage standard error of volume is based on the large volume figure.

The lower part of Table 1 shows how these figures may be deceptive in the two examples given. For the woodlot the standard error of the volume is only 5.75 percent, while the standard error of the growth is 19.94 percent. With only a hasty look at these percentages, one might condemn the growth figure as the less precise. The figures from the industrial forest district, with its tiny net growth, bring out forcibly the ludicrous relationships that may appear through the use of percentages.

Should the reader find the statistical portions of this article difficult to follow and feel doubts about the validity of the relationships claimed, he may satisfy himself by thinking of a simple hypothetical situation or even placing it on paper. He may assume a sample of 10 permanent plots from a tract with a wide variation in the initial volume. He may further assume that before remeasurement each plot grows exactly the same amount. Then the volume sampling error of the first and second average volumes will be large, but the sampling error on the growth figure will be zero, since it shows no variation at all. If only temporary plots had been established each time, there would be no way of knowing that each plot had exactly the same growth, but with permanent plots this zero variation is evident and calculable.

While many problems remain in the application of permanent in-

ventory plots to growth determination, such plots seem to hold the best prospects for giving accurate growth figures, which are so important in planning the management of a wood-producing property. With frequent remeasurement, growth estimates may be sensitive to changes in management practices and environmental changes in the forest, and enable the forest manager to adjust practices accordingly. Mortality, from various sources, and ingrowth may be precisely followed. Coupled with the use of punch cards and rapid summary on data-processing machines, permanent inventory plots are an important aid to the forest manager in the control of production from his property.

Summary

The remeasurement of permanent sample plots is here shown to give much greater precision to the estimate of growth rate of a forest property than has generally been accorded such estimates. In two examples, permanent plot location is shown to reduce sampling error of growth to one-fourth the sampling error attainable from successive inventories with temporary plots. On a 55-acre woodlot the standard error of the growth estimate for a nine-year period on 1/5-acre permanent plots was ± 33.26 board feet, while an equal number of temporary plots would have given ± 121.57 board feet. Only 75 permanent plots were needed, whereas about 216 temporary plots at each measurement would have been necessary to give equal precision.

A similar analysis of a 90,000-acre forest showed that 254 permanent plots gave a precision that would have required 3,970 temporary plots.

The statistical equations necessary for these calculations are discussed, pointing out that permanent plots allow pairing first and second measurements and, therefore, working directly with differences for each plot rather than only the simple difference of two averages. As a result forest managers can obtain from a series of permanent plots, growth estimates much more precise than the volume estimates from these same plots. Foresters working up inventories on business machines may use the same equations for computing limit of error on growth estimates as they have been using on volume estimates.

The relationships shown here are only apparent when sampling errors are expressed in absolute units of board feet, cords, cubic feet, etc. The practice of expressing sampling errors in percentages can easily lead to overlooking this advantage of permanent plot location.

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The Northern Region of the U. S. Forest Service in September published a report which describes what happened as a result of the earthquake within the Madison River Area of the Gallatin and Beaverhead National Forests. It is not intended to be a complete report, but documents the occurrence and makes possible a better understanding of the Montana disaster of August, 1959, and the events following it. *Hebgen Lake-Madison River Earthquake Disaster* summarizes Forest Service actions following the earthquake and relates them to those of the many other federal, state, county, and other agencies that undertook to assess conditions and render assistance in every way possible to persons in the affected area. Source: Regional Forester, U. S. Forest Service, Federal Building, Missoula, Mont.

Fertilizer Trials with Loblolly Pine in Southern Arkansas

Robert Zahner

A RECENT STUDY measured the growth response and mineral uptake of fertilized young loblolly pines (*Pinus taeda* L.) in established plantations already making good growth on average and above-average sites. With the current trend toward large-scale fertilization of forests on average sites, the results of this one-application trial may be of interest. Most other investigations of forest fertilization have dealt largely with seedlings at planting time, or with unhealthy trees on poor sites.

Design of Study

Three plantations, aged 4, 5, and 8 years, were located in south Arkansas[1] in 1954. The trees had been planted at a spacing of about 6 by 8 feet, and, since survival had been excellent, the stands had well over 800 trees per acre. The sites (Table 1) were typical of much of the Coastal Plain uplands and terraces of the region, and all soils are of common and extensive occurrence. Early growth of all plantations had been normal and healthy, the trees averaging 9, 11, and 20 feet tall, respectively, on the three areas. Figure 1 shows a portion of the oldest plantation in 1954.

Six fertilizer treatments were replicated three times in each of the three plantations, in a randomized block design. Thus 18 plots were established in each plantation, each plot containing 20 trees plus an isolation strip. The 20 trees were measured annually at the end of the growing season. Tree heights were measured to the nearest 0.5 foot and diameter outside bark to the nearest 0.1 inch. Because of the shortness of the trees in the two youngest plantations, all diameters were measured at 2 feet instead of 4½ feet above ground.

Soil samples were collected at the end of the first growing season following the fertilizer application. Foliage samples were taken from the current year's needles on randomly selected trees after each of the first four growing seasons.

The six fertilizer treatments were applied only once, in March 1954. Fertilizers were broadcast by hand uniformly over the entire plot and isolation strip. The treatments were:

N—Ammonium nitrate, to supply 100 pounds of N per acre.

3N—Ammonium nitrate, to supply 300 pounds of N per acre.

3NPK—Mixture of 3N treatment plus superphosphate and muriate of potash, to supply 300 pounds of N, 200 pounds of P_2O_5, and 120 pounds of K_2O per acre.

3NM—Mixture of 3N treatment plus a minor-element fertilizer containing Fe, Zn, Ca, Mn, Bo, and Mg, to supply 300 pounds of N and 200 pounds of the minor-element mixture per acre.

3NPKM—Mixture of 3NPK treatment plus the minor-element fertilizer, to supply 300 pounds of N, 200 pounds of P_2O_5, 120 pounds of K_2O, and 200 pounds of the minor-element mixture per acre.

C—Control, no fertilizer.

Soil and foliage samples were analyzed by the Soil Testing Laboratory, Agronomy Department, University of Arkansas, Fayetteville. Soils were analyzed for total N, available P_2O_5, K, Ca, and Mg, total cation exchange capacity, and pH. Foliage was analyzed for total N, P_2O_5, K, Ca, Mg, and Na in 1954 and only for total N in subsequent years. Foliage samples were taken for all treatments the first year, but in other years only the 3N and control treatments were sampled.

Standard Kjeldahl methods were used for the nitrogen determinations, and a spectrophotometer was employed in the other analyses.

TABLE 1.—SOIL AND SITE CHARACTERISTICS OF THE THREE PLANTATIONS IN 1954

	4-year-old plantation	5-year-old plantation	8-year-old plantation
County	*Union*	*Clark*	*Dallas*
Soils:			
Series name	Boswell	Myatt	Norfolk
Surface thickness	10 inches	24 inches	20 inches
Surface texture	Sandy loam	Fine sandy loam	Coarse sandy loam
Subsoil color and texture	Red clay	Mottled grey-yellow sandy clay loam	Yellow sandy clay loam
Subsoil drainage	Poor	Imperfect	Good
Topography:			
Position	Rolling upland	Terrace	Upper slope
Slope	3-5 percent	2 percent	5 percent
Drainage	Good	Imperfect	Good
Loblolly pine site index[1]	80	80	90

[1]Estimated from soil properties.

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[1]This study was made possible by the Murphy Corporation, the Gurdon Lumber Company, and the Fordyce Lumber Company, on whose lands the experimental areas were established.

Results

Height growth. — Analysis of variance showed no differences in height growth attributable to any fertilizer treatment. Unfertilized trees grew as well as any others, all treatments averaging about 3 feet per year for the first two years after the application of fertilizers. At the end of five years, no significant difference in tree heights could be attributed to treatment, and all plantations had grown nearly 14 feet.

Diameter growth.—All fertilized trees made more diameter growth initially than did the controls, although this effect lasted only a few years. Table 2 summarizes annual diameter increments for each plantation. All plots were measured in the first, second, and fifth years after fertilizer application, while only selected treatments and plantations were measured in the third and fourth years.

Analysis of variance showed that in 1954 and 1955 trees in treatments N, 3N, 3NPK, 3NM, and 3NPKM all made significantly more diameter growth than did the controls. In 1954, trees in treatments N and 3N did not differ significantly. Thus the level of nitrogen application caused little variation the first year, when any tree receiving additional nitrogen grew about 20 percent more than control trees. In 1955, however, trees in treatments N and 3N were significantly different from each other, respectively growing 12 and 23 percent more than the controls.

The third year after treatment, 1956, the effect of fertilizer on current growth had largely disappeared. No significant difference appeared between the two levels of nitrogen, and only in the oldest plantation did fertilized trees make faster diameter growth than control trees. Measurements in the oldest plantation in 1957 showed no difference there at the end of the fourth growing season.

At no time during the study was there any significant difference in growth among trees in treatments 3N, 3NPK, 3NM, and 3NPKM—an indication that the addition of P,

FIG. 1.—Part of the 8-year-old plantation in 1954. Before fertilizing, trees averaged 4.5 inches in diameter and 20 feet tall.

FIG. 2.—Foliage of fertilized trees (left) was greener, longer, denser, and persisted for six to eight months more than the foliage of controls (right). The fertilized tree pictured here received the 3NPK treatment, but is typical of all other fertilizer treatments.

TABLE 2.—ANNUAL AND TOTAL DIAMETER GROWTH OF FERTILIZED AND CONTROL TREES IN THE THREE PLANTATIONS. DATA ARE AVERAGES OF THREE PLOTS IN EACH PLANTATION

Year of growth	Age of plantation[1]	Average diameter[1,2]	Treatment					
			N	3N	3NPK	3NM	3NPKM	C
	Years	*Inches*	*Inches*					
1954	4	1.9	0.77	0.73	0.77	0.73	0.70	0.63
	5	2.0	.80	.77	.77	.77	.80	.63
	8	4.5	.60	.57	.57	.63	.63	.47
		Av.	.72	.69	.70	.71	.71	.58
1955	5	2.6	.70	.77	.83	.83	.77	.63
	6	2.8	.87	.90	.97	.83	1.03	.80
	9	5.1	.60	.70	.77	.67	.73	.50
		Av.	.72	.79	.86	.78	.84	.64
1956[3]	6	3.3	.63	.63	....	....	....	.63
	7	3.6	.60	.57	....	....	....	.57
	10	5.7	.50	.43	....	....	....	.33
		Av.	.58	.54	....	....	....	.50
1957[3]	7	....	....	....	....	....	....	....
	8	....	....	....	....	....	....	....
	11	6.1	.53	.50	....	....	....	.50
		Av.	53	.50	....	....	....	.50
1954-58, incl. (5 yr. total)	9	5.2	3.27	3.29	3.36	3.36	3.46	2.93
	10	5.0	2.95	3.10	3.10	2.92	3.03	2.71
	13	7.0	2.46	2.49	2.58	2.50	2.48	2.21
		Av.	2.89	2.96	3.01	2.93	2.99	2.62

[1]At beginning of current growing season, except the 1954-58 total, which is at end of 1958 season.
[2]At two feet from ground.
[3]Not all treatments or plantations were measured in 1956 and 1957.

K, or minor elements did not improve growth over that attributable to 3N alone.

As indicated in Table 2, the average diameter-growth superiority of fertilized trees over controls was from 10 to 15 percent during the total period from 1953 through 1958. A final analysis of variance failed to find significant differences among the 5 fertilizer treatments at the end of 5 years. Trees given the higher level of N and the two treatments with P and K averaged better growth than the others, but not significantly so.

Soils.—After the first growing season, above-normal amounts of phosphorus and potassium were still detectable in the soil on plots of treatments 3NPK and 3NPKM (Table 3). Nitrogen levels in the soils were about the same on control as on fertilized plots. Evidently most of the additional N had been picked up by trees or lost through leaching by the end of the first season.

Other fertility values, available Mg and Ca, exchange capacity, and pH, were the same in all treatments.

Foliage.—Trees picked up N, P, and K in substantial amounts on plots receiving these elements in fertilizer (Table 4).

At the end of the first growing season, all fertilized trees contained significantly more nitrogen in their foliage than any of the control trees. Trees fertilized with 300 pounds of N per acre contained more foliar nitrogen than trees fertilized with only 100 pounds.

For three growing seasons after fertilization, foliar nitrogen was higher in trees receiving the 3N treatment than in the controls, but the amounts of foliar nitrogen declined through 1955 and 1956, until by 1957 the difference between the 3N treatment and the control had disappeared.

In the first year foliar phosphorus and potassium were significantly higher in trees in treatments 3NPK and 3NPKM than in any other treatment or the control. Foliar magnesium and calcium were the same for all treatments and the control.

At the end of the 1954 and 1955 seasons all fertilized trees had healthier-looking crowns than the controls (Fig. 2). Color was richer, and needles were longer and persisted for six to eight months more than on controls. This qualitative effect was temporary and had disappeared by 1957.

Discussion

The quantities of fertilizer were large for a single application; 100 pounds of N per acre was almost as effective as the most elaborate 3NPKM treatment. Possibly smaller applications repeated periodi-

TABLE 3.—RESULTS OF FERTILITY ANALYSIS OF SOILS, AT THE END OF THE FIRST GROWING SEASON AFTER FERTILIZATION. DATA ARE AVERAGES FOR ALL PLANTATIONS, NINE REPLICATIONS OF EACH TREATMENT

Nutrient	Treatment					
	N	3N	3NPK	3NM	3NPKM	C
Total N[1] (percent)	0.030	0.029	0.026	0.032	0.031	0.025
Available P_2O_5 (lbs. per acre)	8	8	40*	9	49*	10
Available K (lbs. per acre)	54	47	86*	48	71*	60

[1]None of the soils differed significantly from the control in percent of N.
*Difference from control is significant at the 5-percent level or better.

TABLE 4.—RESULTS OF FOLIAR ANALYSIS OF CURRENT NEEDLES AT THE END OF THE FIRST GROWING SEASON AFTER FERTILIZATION. DATA ARE AVERAGES FOR ALL PLANTATIONS, NINE REPLICATIONS OF EACH TREATMENT

Nutrient	Treatment					
	N	3N	3NPK	3NM	3NPKM	C
	Percent					
Nitrogen	1.31*	1.43*	1.55*	1.45*	1.47*	1.12
Phosphorus	.085	.084	.105*	.085	.100*	.091
Potassium	.466	.484	.566*	.477	.550*	.475

*Difference from control is significant at the 5-percent level or better.

cally over the five years would have maintained growth at the accelerated rate; possibly a single application of nitrogen in a more slowly available form would have had a more lasting effect.

The lack of height-growth response is not readily explained. Loblolly, like other southern pines, characteristically maintains a strong apical dominance under most environmental influences. Perhaps on average unfertilized sites the growing stem-tip receives the materials necessary for good height growth at the expense of the rest of the tree, and hence is possibly not so sensitive to changes in fertility. In this study the control trees were growing three feet per year, a rate that may have been limited only by moisture supplies and the physical characteristics of the soil. On sites with known deficiencies of certain nutrients, by contrast, fertilizers have increased height growth of other coniferous species (*1, 3, 6*). Diameter growth is regulated by the size and health of the whole crown (*4, 9*). The diameter response to fertilizer noted in this study is consistent with that found for other conifers (e.g., *2, 5, 7*).

While additions of nitrogen, phosphorus, and potassium to the soil influenced the composition of current green foliage at the end of the growing season, only nitrogen gave a significant growth response. Needles formed in 1954, rich in nitrogen, remained on the trees during most of 1955, the year when diameter growth responded most strongly to fertilization (Fig. 3). During 1955 some of the nitrogen in the 1954 needles must have been translocated into the new 1955 needles, for the latter contained significantly more nitrogen than needles from control trees. However, translocation involved progressively less nitrogen in subsequent years, with the result that both foliar nitrogen and diameter growth had declined to a level with the controls by 1957.

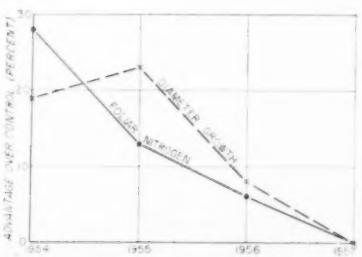

FIG. 3.—Relationship between foliar nitrogen and diameter growth for the 3N treatment only, expressed as advantage over control.

Some of the nitrogen originally applied as ammonium nitrate and picked up by the trees must have been returned to the ground each year through leaf fall. How much was recycled back through the tree is not known, but undoubtedly much was lost through leaching or was tied up by micro-organisms. In any case, as the young trees grew larger each year, the additional nitrogen from fertilizer was diluted throughout larger crowns, stems, and roots, and was also gradually returned to the soil and lost. After five years, therefore, the effect of the one application had nearly disappeared.

The growth response to nitrogen was not unexpected. This nutrient is almost universally scarce throughout the southern Coastal Plain. Although consistent and statistically very significant, the difference in growth due to nitrogen is not very impressive. Total diameter growth over five years was good in all plots, averaging 3.0 inches for the nitrogen-fertilized and 2.6 for the control trees. The net diameter differences between fertilized trees and controls are now small. Nevertheless, the fact that the 3N treatment resulted in 25 percent more diameter growth and the N treatment in 17 percent more in the first two years is an indication that a second application in the third year would have resulted in continued greater growth differences.

Field trials such as these point up the need for further research in fertilizing the southern pines. Walker (*8*) suggests future studies of a more basic nature (for example, pine nutrient studies employing radioactive isotopes) before more large field trials are made. Certainly the effects on disease and insect susceptibility, on wood quality, and on the perennial growth pattern of pines should be better known before fertilizers are used on a large scale as part of commercial woodland operations.

Summary

In the spring of 1954 six fertilizer treatments were replicated nine times in 4- to 8-year-old loblolly pine plantations in southern Arkansas. Fertilizers were applied only once. Average height and diameter growth of 20 trees in each replication were taken as the unit observations in analysis of variance. Chemical analysis of soil and foliage samples indicated the mineral uptake by trees in each treatment.

Height growth was not affected by any treatment tested but diameter growth was stimulated for two growing seasons by nitrogen fertilizer. Three hundred pounds of N per acre gave better growth than 100 pounds the second year, but not the first. The addition of phosphorus, potassium, or minor elements did not significantly increase growth over nitrogen alone.

Foliar analysis showed that N, P, and K were picked up from fertilizers, the N in proportion to the quantity applied. The nitrogen content of fertilized needles diminished to a level with controls after three years.

Total five-year diameter growth increase due to fertilizer was about 10 percent for a single application of 100 pounds of N per acre. The more elaborate fertilizers did not significantly further increase growth over the total period.

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Effect of Prescribed Burning and Other Seedbed Treatments on Ponderosa Pine Seedling Emergence

A. M. Schultz and H. H. Biswell

PRESCRIBED BURNING for game habitat improvement and reduction of fuel is being studied in ponderosa pine forests in California (*2, 10*). After a good seed year for pine in 1953 it was evident that far more seedlings emerged the following spring on plots burned in the spring of 1952 and autumn of 1953 than on neighboring unburned plots. It seemed desirable then to compare prescribed burning to several other seedbed preparation practices. The opportunity came in 1956 when an excellent crop of seeds was produced.

An experiment was designed wherein eight separate treatments or conditions were sampled with three to six 4x4-foot plots in May of 1957 when seedling emergence was thought to be complete. Both live and dead seedlings were counted. No attempt was made to study seedling survival after this date. In the center of each plot a seed trap had been placed in August 1956. Ponderosa pine seeds were removed and counted weekly during the entire period of seed fall (Fig. 1). The treatments were (1) unburned, at least for 10 years, (2) burned fall of 1953, (3) burned fall of 1955, (4) burned October 1956 when seed fall was about one-half over, (5) burned fall of 1955 and rototilled in September 1956, (6) brush removed with bulldozer, summer of 1956, (7) litter hand raked to mineral soil, August 1956, and (8) untreated manzanita thicket.

The prescribed burning was done during the month or year indicated, always in the rainy season and when the needles burned readily but the duff layer was too wet to burn. Tilling was done by going over an area twice with a garden rototiller; depth of tillage varied between 4 and 6 inches. The bulldozer was used to uproot the brush and push it into large piles. Consequently, the soil surface was thoroughly scarified.

Naturally, few seedlings can emerge on plots where but a few seeds had fallen; and the chances for many seedlings are greater where the seeds are numerous. Thus the number of sound ponderosa pine seed falling in each trap was used to adjust the seedling numbers of the surrounding plot (Table 1). Adjustment was made with the error (within treatment) regression coefficient between seed and seedling numbers. Analysis of covariance was used to test the significance of treatment differences and these are indicated in the table by the rank, column 6. The last column, percent emergence, was included for comparison with records of other research, in which equal seed numbers for the various treatments are assumed.

Reducing the litter made an excellent seedbed for ponderosa pine, whether by hand raking or burning. This seemed to be true also for sugar pine, but for this species either the seed source or the number of plots was too scanty for any statistical treatment. Foresters in other areas found that prescribed burning or slash burning enhanced natural regeneration in shortleaf and loblolly pine in Arkansas and Texas (*6, 7*), longleaf pine in Louisiana (*4*), and in Douglas-fir in Oregon (*1*). This effect is not restricted to conifers. Yellow-poplar in eastern United States (*3*) responded in the same way.

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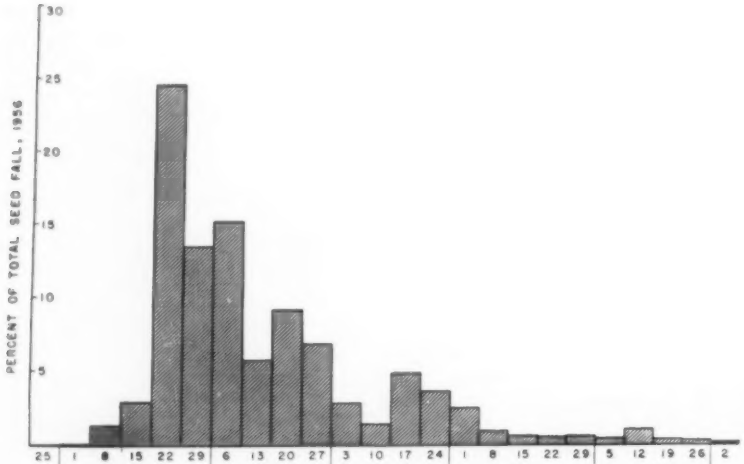

FIG. 1.—Percent of total seedfall for 1956-1957 season recorded at weekly intervals.

Comparison of treatments (1) to (4) indicates that the more recent the burn, the greater the seedling numbers. This agrees with the work of Meyer in Arkansas who reports that plots of shortleaf and loblolly pine cut and burned just prior to the maximum period of seed fall in October 1947 had three to four times as many seedlings as plots similarly prepared the year before (*7*). Ferguson found that with each additional year between burning and seedfall, germination of shortleaf pine in Texas was reduced by about 1.4 percent (*6*). Our results show still greater reduction.

It should be noted that the 1956 burn was made after some of the seed had already fallen. So it is possible that half of the seeds had been destroyed by fire. The adjusted number of seedlings per 100 square feet, based on this assumption, would be 124 instead of 80 as in Table 1. Loss of loblolly pine seeds by winter fires was found to depend on the time of burning in respect to seedfall and on the intensity of the fire (*5*).

Rototilling increased seedling emergence significantly over burning (treatment (5) was superimposed on (3). There was no treatment of rototilling alone. This method scarified the soil surface and incorporated the litter into the mineral soil. A similar treatment in ponderosa pine forest was reported by Tackle and Roy (*8*) where scarification with an offset disk resulted in the germination of over 33,000 pine seedlings per acre, compared to 5,000 on a ground cover of a light duff layer and 2,000 with medium to heavy duff.

In addition to the rototilled plots used in the experiment, parallel strips 100 feet long were tilled in September and November. Seed fall was not measured but seedlings were counted at intervals along the strips and on corresponding check plots immediately adjacent to them (Table 2). While there were slightly more seedlings per unit area on the September treatment, the difference between treated and check plots was greater on the November tilling. The *t* value (ratio of mean difference to standard error of mean difference) was 50 percent larger for the November than for the September date.

Tilling in November probably covered some of the seed already fallen; other seed filtered into the freshly cultivated soil to be covered by the next rain. Practically no rain fell between September and mid-November.

As with burning, the age of the mechanically prepared seedbed—tilled, disked, bulldozed, or logged—is an important factor in determining the number of seedlings to emerge (*7, 9*). Deterioration of seedbed conditions through time is caused by the falling of more and more needles, crusting and smoothing of soil surface by rain and wind, and by gradual build-up of competition.

Reference has been made to studies in widely separated areas on several different tree species. From these studies and ours, three principles evolve: (1) mineral soil should be exposed so that the seed and subsequently the seedling root can be in contact with a medium of high moisture-holding capacity; (2) the amount of dead litter which may shade, smother, or obstruct the emergence of the newly germinated seedling should be reduced; and (3) since the seedbed deteriorates rapidly, it should be prepared just prior to or during the seedfall from heavy cone crops.

TABLE 1.—EMERGENCE OF PONDEROSA PINE SEEDLINGS UNDER EIGHT SEEDBED TREATMENTS

Treatment	No. of plots	Seeds per trap	Seedlings per 100 sq. ft.	Adjusted No. seedlings per 100 sq. ft.	Rank[2]	Emergence Col. 4/Col. 3 x 50
(1) Unburned	6	17	10	(-11)[1]	4	1.2
(2) Burned fall 1953	6	14	8	4	4	1.1
(3) Burned fall 1955	6	8	39	67	3	9.8
(4) Burned Oct. 1956	6	16	96	80	2	12.0
(5) Rototilled 1956; otherwise same as (3)	6	7	64	97	2	18.3
(6) Bulldozed summer 1956	6	7	33	66	3	9.4
(7) Raked Aug. 1956	4	24	310	196	1	25.8
(8) Manzanita thicket	3	12	8	14	4	1.3

[1]Negative value is meaningless but can be interpreted as an exceedingly small number of seedlings compared to the large number of seeds that fell on the plot.
[2]There is a significant difference at .05 level between adjusted means of treatments having different ranks, no difference where the ranks are the same.

TABLE 2.—SEEDLING COUNTS PER 100 SQUARE-FOOT PLOTS LOCATED ALONG TILLED AND UNTILLED PARALLEL STRIPS. TILLING WAS DONE TWICE, SEPTEMBER AND NOVEMBER 1955

	1	2	3	4	5	6	Av.
Sept. tilling	120	146	45	23	182	204	120
Check Plot	65	65	43	24	85	156	73
Nov. tilling	116	183	53	54	150	116	112
Check plot	46	60	22	26	76	64	49

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Prospects for Industrial Consumption of Wood and for Development of Forest Economy in USSR Under Seven-Year Plan, 1959-1965

P. V. Vasilyev

THE TARGET FIGURES for the development of the national economy of the USSR in 1959-1965 determine the ways for a new powerful upsurge and further flourishing of all the branches of economy and culture of the country, and the ways for USSR participation in the peaceful competition of countries striving to raise the welfare and cultural standards of the people. The decisive factor in this competition will be the achievement of a rate of per capita production of the most important goods which would exceed that in the competitor countries.

The realization of this highly complicated task requires, among many other things, a further expansion and improvement of the whole industry and of all the branches of industrial wood consumption. This, in turn, calls for important steps aimed at improving and intensifying the forest economy.

The following four features are characteristic of the seven-year plan for the development of the forest products industry and the forest economy of the USSR, whose broad objectives are reflected in the target figures for the development of the USSR national economy in 1959-1965.

First, the seven-year plan for the development of the USSR forest products industry aims at an active and preferential development of the woodworking and processing branches, the development of logging being made dependent on the expansion of the national economy, with an obligatory condition of rational and economic utilization of all the stocked wood. Under the seven-year plan over 60 percent of all the capital investments allocated for the forest industry throughout the country is to be directed toward the development of the timber industry, as against 20 to 30 percent in the years of the fourth and the fifth five-year plans. In the domain of wood processing the most rapid development is envisaged in branches of chemical wood processing, particularly in the pulp and paper industry. Twenty-two percent of all capital investments will be directed toward the development of this branch, as compared with 3-4 percent during the years covered by the post-war five-year plans. The yield of all other products of chemical wood processing will increase greatly.

The second feature of the plan is the provision for covering nearly all the additional needs for wood and products of woodworking and processing by way of mastering and utilizing forest resources of forest-rich districts in the North, the Urals, West and East Siberia. In particular, a sizable portion of the above-mentioned capital allocations both for the development of logging and for woodworking and processing will be directed to forest-rich districts of East Siberia, the Tomsk and Tyumen regions, the Pechora district, etc.

The third feature of the seven-year plan for the development of the timber and forest products industry of the USSR is the widest industrial application of the principles and technology of integrated utilization of timber.

Finally, the fourth feature is the effort to find and establish new and improved interrelations between the country's forest economy and forest products industry.

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Target Figures

Below we present some approved target figures for the development of the industries concerned.

As provided by the target figures for the development of the national economy of the USSR, by 1965 cellulose production in the country is to be raised to about 4.8 million tons, i.e. 2.3 times that of 1958. To supply the needs of the artificial fiber industry, the production of rayon cellulose will be increased to 580,000 tons, i.e. by a factor of 4.5. Paper production is to rise by 1965 to 3.5 million tons which exceeds that of 1958 by 60 percent. Cardboard production will increase to about 2.8 million tons, i.e. 4 times, cardboard deliveries growing from 70,000 tons in 1958 to 1,500,000 tons in 1965. The production of newspaper stock will also increase by 80 percent.

The industry producing fiberboard and particle-board is to undergo enormous expansion. The output of fiberboard will rise from 38 million square meters to 300 million, i.e. 8 times, and that of particle-board, from 420,000 cu.m. to 3,500,000 cu.m., or 83 times.

Among the branches of the mechanical woodworking industry a considerable further development is projected in the field of prefabricated house production. The latter will be extended from 5,500,000 sq.m. of housing area in 1958 to 20 million cubic meters in 1965. Furniture production is to increase by a factor of 2.4, plywood output rising from 1.2 million cubic meters to 1.75 million.

The output of lumber in 1965 is envisaged only within the amount which the sixth five-year plan provided for 1960, namely 92-95 mil-

lion cubic meters. As to removals where the sixth five-year plan set 393 million cubic meters of timber for 1960, the seven-year plan keeps the 1965 target down to 372-378 million cubic meters, no account being taken of small producers.

In the fulfillment of these tasks set by the seven-year plan for the development of the forest products industry of the USSR the decisive role will be played by the Russian Federation, which is evidenced by Table 1.

It is clearly seen from the figures quoted that both for the USSR and the RSFSR especially high rates of growth are planned in the sphere of chemical manufacturing processes.

All this will cause great changes in the whole structure of the country's forest products industry and will enable it to insure a much better coverage of the needs of the national economy and the population at the expense of a relatively smaller amount of raw materials.

The possibilities of enormous wood economy under conditions of a highly developed woodworking industry become particularly obvious when comparing the production of wooden and cardboard tare (containers). At present the wooden tare industry of the USSR consumes about 25 million cubic meters of wood, ingnoring recoverable tare.

If the existing rates of wood consumption for tare production are maintained, this consumption may rise to 40 million cubic meters by 1965. The seven-year plan aims at bringing the production of tare cardboard to 1,500,000 by 1965, thus relieving half of the above-indicated amount of industrial wood, i.e. up to 20 million cubic meters, as almost all the mentioned amount of tare cardboard could be produced from non-industrial wood, and wastes resulting from mechanical woodworking. It should be noted here that cardboard tare (containers) will be three times cheaper than those made of wood.

Production of fiberboard and particle-board will insure considerable economy of wood and money.

TABLE 1.—EXPANSION OF THE BASIC BRANCHES OF THE FOREST PRODUCTS INDUSTRY OF THE RUSSIAN SOCIALIST FEDERATION OF SOVIET REPUBLICS UNDER THE PLAN FOR THE DEVELOPMENT OF THE NATIONAL ECONOMY IN 1959-1965

Branches	1958	1965	Contribution of the RSFSR to the USSR plan for 1965	1965/1958 ratio
			Percent	*Percent*
Wood removals				
Total, mln. cu.m.	276.7	327-334	90	118.2-120.7
Including industrial wood	192.2	243-248	87	126.5-129.1
Lumber, mln. cu.m.	57.3	77.5	84	135.3
Plywood, thous. cu.m.	802.5	1632	93	203.3
Paper, thous. t.	1743	2874	82	165.0
Cardboard, thous. t.	433.5	23660	80	5.4 times
Particle-board, thous. cu.m.	21.8	2955	84	135 times
Fiberboard, mln. sq.m.	32.7	277	93	8.5 times

As was pointed out previously, it is planned to cover the country's growing needs for timber by intensified logging and wood processing in forest-rich districts of the North, the Urals, and Siberia. In 1965 the northern districts of the European part of the USSR will supply 19.5 percent of all the industrial wood throughout the Soviet Union, as against 13 percent at the end of the fifth five-year plan period, while the contribution of the Urals will rise to 18 percent as compared with 14.3 percent in 1940, and that of Siberia will increase from 8.8 percent in 1940 to 31 percent in 1965.

As can be seen, Siberia will show an especially great increase in logging. In absolute units, timber shipments from Siberia will increase from 67 million cubic meters in 1958 to 105-110 million cubic meters by the end of the seven-year plan period.

These shifts and the economic utilization of the stocked wood will eliminate the necessity of intensive felling of trees in the European part of the country, and conditions will be created for a more rational management of the forest economy and for a rise in

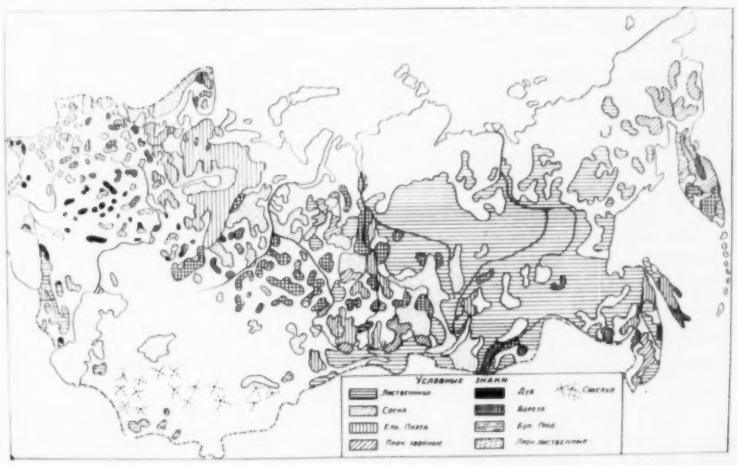

FIG. 1.—Map of forests of the USSR showing distribution of tree species. Prepared in 1956 by the All-Union Forestry Department in the Ministry of Agriculture. Explanation of key is as follows: Left column, reading down: Larch, Scotch Pine, Spruce-Fir, and Other Conifers. Right column: Oak, Birch, Beech-Hornbeam, Other Broadleafs. Symbol in upper right of box: Saksaul.

forest productivity. In particular, it is planned to reduce wood deliveries in the Ukranian SSR by 1965 from 13.4 million cubic meters to 7 million, in the Byelorussian SSR from 6.6 to 4.4. million, in the Lithuanian SSR from 1.1 to 0.7 million, in the Latvian SSR from 2.7 to 1.9 million, and in the Esthonian SSR from 1.6 to 1.1 million cubic meters.

In Siberia, particularly in its eastern part, woodworking and processing will undergo enormous development. Sawed timber production during the forthcoming seven-year period is to grow from 13 million cubic meters in 1958 to 28 million, which will be twice the volume of sawed goods produced in the whole of czarist Russia in 1913. Plywood production will increase from 52,000 cubic meters to 403,000, which is also twice the output of all Russia's plywood factories in 1913. Furniture production will increase 4 times, and that of ethyl alcohol, 2.5 times.

Integrated Utilization

The application of the principles of integrated wood utilization during the seven-year period may be illustrated by the plans for new construction in Siberia.

According to the papers discussed at the Conference of the USSR Academy of Sciences for the development of productive forces in East Siberia, held in July, 1958, several huge forest products industry centers, comprising a whole complex of various enterprises for woodworking, processing and logging, will be created in this vast forest district of our country during the seven-year period.

One of such centers will be established in the Eniseysk-Maklakov district. It is planned to build here two Enisey sawmill, woodworking and chemical combine plants, each having an annual capacity of 680,000 cubic meters of lumber, 120,000 cubic meters of timber for manufacturing railroad cars and 50,000 cubic meters of particle-board. Another combine plant — Novo-Maklakovsky — will yield 680,000 cubic meters of lumber and 950,000 cubic meters of particle-board annually. This enterprise will include a 104,000 cubic meter plywood plant and, somewhat later, a huge pulp and paper combine plant with an initial annual capacity of 105,000 tons of paper, 12,000 tons of cardboard and 160,000 tons of cellulose. An intermediate shipment — processing warehouse for 1,200,000 cubic meters of wood will be built to serve the needs of wood consumers.

The second combine plant similar in size to the one discussed above will be established in the Bratsk district where the country's most powerful hydroelectric station is being built. Here, in addition to the existing enterprises, there will be built the Novo-Bratsky sawmill, woodworking and chemical combine plant with a rated output of 1,360,000 cubic meters of lumber and 160,000 cubic meters of lumber for manufacturing machines. The plan also provides for the construction of a 104,000 cubic meter plywood plant and a furniture factory producing an equivalent of 30-35 million rubles. The wood waste from all these enterprises will be shipped to a large tare cardboard factory being constructed simultaneously, which is to produce 300,000 tons of cardboard by 1965.

In respect to their capacity both these industrial centers will be closely comparable with the Archangel center of our forest products industry which was created principally during the pre-war five-year plan periods.

Many new large forest products industry mills and factories will appear in the Krasnoyarsk district which has already grown into a big forest products industry center of Siberia. A considerable development is projected for the forest products industry of the Chita region, the Buryat Autonomous Soviet Socialist Republic, Yakutia and the Tuva Autonomous Region.

Industry Construction in West Siberia

Extensive forest products industry construction, although on a more moderate scale, will be carried out in forest districts of West Siberia. The importance of the development of logging and wood processing in this district, which is not so rich in forest resources, is determined, on the one hand by the needs of the district itself, which now possesses a highly developed industry, and on the other by the fact that the delivery of timber and products from West Siberia to the European part of the USSR is cheaper indeed than from East Siberia. Industrial woodworking and processing in West Siberia will develop (account being taken of the planned extension of the transport network) in the districts of Bely Yar, Baturino and Asino in the Tomsk region and in the Natykary district of the Tyumen region. Large sawmill and woodworking combine plants, plywood plants, pulp and paper combine plants and wood-chemical enterprises will also be built here.

Intensification of Management Practices

The planned exploitation of numerous new forest areas in the North, the Urals, and Siberia, as well as the necessity of improving reforestation in the areas of former fellings within these districts, and the forthcoming extension of forest melioration works, etc., call for a substantial rise in the development level of the forest economy in these districts. In particular, at regions where until now one could be content with rough inventory estimates and forest management on the basis of the simplest methods, it will be necessary to carry out more detailed accounting and forest management operations. Special attention should be given to reforestation, fire, and pest control.

As all these works are beyond the limited possibilities of the conventional and complex forest dis-

tricts[1] in forest-rich regions, the seven-year plan stipulates that the manpower and technique of logging organizations should be widely used for this purpose.

In forest-deficient regions of the country, on the contrary, all kinds of logging work are concentrated in the district forest economies. Thus, forest enterprises of both types, e.g. logging enterprises and forest management economies, carry out all kinds of forest work. As for forest control, irrespective of users, it will be provided by the Central Forest Departments on Union Republics.

The target figures for the development of the forest economy of the USSR envisage a number of measures for the improvement of the forests and for increasing their productivity.

The seven-year plan foresees the following forest-economy operations throughout the country:

New and repeated forest management works are to be carried out over an area of 262 million hectares, and the total area of managed forests in the country will reach 467 million hectares.

Improvement fellings will be extended as follows: crown lightening by 100 percent, clearing by 79 percent, sparsing by 35 percent, with a simultaneous reduction in passing fellings by 38 percent and sanitary fellings by 42 percent[2]

Silviculture works will be considerably enlarged. The sowing and planting forest area will increase from 609,600 hectares in 1957 to 744,000 in 1965, and the natural reforestation areas from 681,400 hectares to 724,000. This part of the plan especially provides for the creation of poplar plantation covering at least 1 million hectares.

The area of forest for meliorative works will grow from 48,000 hectares in 1957 to 175,000 in 1965.

In forest fire and pest control modern, efficient methods and means involving the use of aircraft, chemistry, etc., will find a still wider application.

The plan foresees a considerable improvement in the mechanization of works in the forest management.

The seven-year plan envisages the following growth of the relative part of mechanized operations: in soil preparation to 70 percent, in silviculture maintenance to 50 percent, and in forest melioration to 90 percent. The listed number of tractors in the forest management is to increase from 10,000 conditional tractors to 18,000. Particular attention should be given to the construction of new machines, especially designed for forest management. It is planned to supply complex forest districts with special tractors, over ten types of ploughs, a number of cultivators, mellowers, cutters, and forest-planting, stubbing, and sowing machines, etc. The availability of such machines, as well as the participation of forestry organizations in forest restoration and melioration, will bring about a marked improvement in the country's forest economy.

Research

The realization of all these tasks will require active cooperation of forest research institutions and higher colleges of the country. Having this in mind and with a view to bringing research work closer to practice some reconstruction of the scientific organization network is being carried out. Thus, three institutions are being set up on the basis of the Forest Institute of the USSR Academy of Sciences: the Silviculture Laboratory of the USSR Academy of Sciences in Moscow, the Forest and Wood Institute in Krasnoyarsk (within the Siberian branch of the USSR Academy of Sciences), and the Forest and Forest-Chemistry Institute of the USSR Academy of Sciences in Archangel. The network of local experimental institutions at complex forest districts and forest industry enterprises will be extended.

With the adoption of the seven-year plan the Soviet forest specialists in the various branches are coming out into a new wide front of creative work.

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[1] A complex forest district comprises a few adjacent forest districts and is subordinated to a district or regional forest economy department.

[2] These notions are specific for Russian silviculture terminology and therefore are hard to translate. They will be better understood by foreign silviculturists with the aid of the following explanations: crown lightening is usually carried out in forests which are up to 10 years old, clearing from 10 to 20 years; sparsing is done in coniferous and hard-leaved high forests from 21 to 40 years old, and in softwood and hard-leaved coppice forests from 21 to 30 years; passing felling in coniferous forests from 41 to 80 years, in hard-leaved high forests from 41 to 100 years, and in softwood and hard-leaved coppice forests from 31 to 40 years (see V. P. Timofeyev and N. V. Dylis, Lesovodstvo, 1953, Moscow, p. 492).

New Data on the Timber Industry of the USSR

W. Donald Bowles

MUCH NEW DATA on the forest resources and the timber industry of the USSR have been made available recently in the form of a statistical handbook.[1] Its publication has been keenly anticipated since 1956, when the Soviet representative to the forestry group of the FAO first indicated such a text was being prepared. Its release has proved illuminating, both for the information disclosed and for the disappointing omissions.

On January 1, 1956, forest-covered area in the USSR totalled 680,945,100 hectares (1.7 billion acres), and the total volume of timber on this area totalled 75,085,020,000 cubic meters (2,600 billion cubic feet). Thus, the Soviet Union is said to possess a forest area roughly three times and a timber volume roughly five times that of the United States.

Table 1 indicates the species and age class distribution of this resource. It is apparent that the Soviet Union has a huge timber reserve of softwoods available for exploitation. A more useful measure of a timber resource than its size is its location, and in this respect the handbook reveals serious limitations in timber availability. Regions in the North, western and eastern Siberia, and the Far East contain approximately 90 percent of mature and over-mature reserves, whereas agricultural, industrial, and housing requirements of the country are mostly in the western and central regions and the South. As a result, wood, often unprocessed, is hauled or floated hundreds of miles, on the average, from the logging site to the final consumer. Only about one-third of sawmill production was carried out in 1940 in the area containing 90 percent of the timber reserve, and in 1955 the figure had dropped to 29 percent. Evidently, additional capacity constructed in the post-war period was situated in the regions of heaviest timber demand, namely, the western and central regions and the South.

Coupled with this was an increase in logging activities in the so-called "timber-surplus" areas of the North and East. The minister of the timber industry, G. M. Orlov, in 1957 suggested that to minimize transportation costs in the future, new capacity be constructed near the sources of raw material.[2] It is doubtful that this will occur to a significant degree over the next few years, and Soviet writers fully expect the average length of timber haul to increase as new and more distant timber supplies are utilized.[3]

Excluding the war years, impressive increases have been registered in logging output (Table 2), but the increase has not approached that in most other branches of industry. Using 1940 as a base year, this comparison becomes clear (Table 3).

From one point of view, the relatively low rate of increase might be considered as consistent with the increasing industrialization of the economy and the use of wood substitutes in construction and for fuel. Figures available on planned output, however, show that this cannot be the whole answer, for in most years actual output has not even reached plan level. Despite the many requirements in wood products, the relatively low rate of production increase apparently represents a high-level planning decision to struggle along on a timber supply which, while large in an absolute sense, is quite modest when compared with the demands of industrial development and the solution of the housing problem which has plagued the Soviet economy since the Revolution.

The main agency charged with the task of timber supply has been the Ministry of the Timber Industry, although its name has varied over time in response to changes in administrative practice and nomenclature. Investment in this branch of industry has been inadequate, with the result that hundreds of logging organizations

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[1] Ministry of the Timber Industry, Planning-Economic Administration. *Lesnaia promyshlennost' USSR: statisticheskii sbornik* (The timber industry of the USSR: statistical handbook), Moscow-Leningrad, Goslesbumizdat. 1957. For a broader look at the Soviet logging industry, see W. D. Bowles, "The logging industry—a backward branch of the Soviet economy." *American Slavic and East European Review*, December 1958.

[2] *Lesnaia promyshlennost'* (Timber industry), January 19, 1957.

[3] Benenson, G. M., and G. M. Bogin. "Novyi preiskurant optovykh tsen na lesomaterialy i planirovanie lesnykh perevozok" (New price list of wholesale prices on wood and the planning of timber transport). *Lesnaia promyshlennost'* No. 6. 1954. p. 29.

TABLE 1.—SOVIET FOREST AREA AND VOLUME AS OF JANUARY 1, 1956
(in millions of hectares and billions of cubic meters)[1]

Type of timber	Total		Age classification									
			Young		Middle		Approaching maturity		Mature		Over-mature	
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
Coniferous	531	65	38	1	64	6	61	7	190	25	180	25
Broadleaf	114	9	26	1	23	2	14	1	29	3	21	2
Total	681	75	71	2	95	8	80	9	230	28	205	28

[1] *Timber Handbook*, pp. 6-7. *Narodnoe khoziaistvo USSR v 1956 godu: statisticheskii sbornik* (The national economy of the USSR in 1956: statistical handbook). Moscow. 1957. Figures are rounded to the nearest whole number. Classifications are not defined.

TABLE 2.—LOGGING OUTPUT IN THE USSR BY TYPE OF LOGGER, 1928-1955 (in millions of cubic meters)[1]

Year	Total Industrial	Fuel	Timber ministry Industrial	Fuel	Collective farms Industrial	Fuel	Self-suppliers[4] Industrial	Fuel
1928	36.0	25.7	[2]	[2]	[3]	[3]	[2,3]	[2,3]
1933	98.0	75.3	62.4	29.4	[3]	[3]	[2,3]	[2,3]
1940	117.9	128.2	55.5	39.2	4.8	8.6	57.6	80.4
1945	61.6	106.8	22.3	21.1	1.7	5.7	37.6	80.0
1950	161.0	105.0	76.0	28.3	7.0	9.9	78.0	66.8
1955	212.1	122.0	112.0	43.0	15.2	13.9	84.9	65.1

[1]*Timber Handbook*. Op. cit. pp. 56-57.

[2]The timber ministry (commissariat) was formed in 1932.

[3]Not indicated in the handbook. The crude state of Soviet timber statistics for this period makes it impossible to isolate farm production of timber.

[4]Derived by subtracting production of collective farms and the timber ministry from total production. It is unclear whether this residual may contain a quantity of wood derived from "improvement cuts" carried out by forestry agencies, not logging enterprises as such. In 1940 35.7 million cubic meters were realized from improvement cuts, and at present such output may exceed this figure. V. P. Timofeev, "Chto dolzhno davat' rubki ukhoda?" (What should improvement cuts yield?), *Les* (Timber), No. 5-6, 1946, p. 46.

TABLE 3.—LOGGING OUTPUT AS COMPARED WITH THAT OF OTHER INDUSTRIES IN THE USSR, 1928-1955[1] (1940-100)

Year	Industrial wood	Fuel wood	Steel	Cement	Coal
1928	32	20	24	33	21
1940	100	100	100	100	100
1945	53	83	73	33	90
1950	136	82	149	180	157
1955	174	100	248	396	236

[1]*Timber Handbook*, pp. 56-57. *Narodnoe khoziaistvo USSR v 1956 godu: statisticheskii shornik* (The national economy of the USSR in 1956: statistical handbook). Moscow. 1957.

have been established by enterprises requiring wood in their normal operations but which were unable to obtain it from central sources of supply. In 1955 self-suppliers produced about 40 percent of the industrial wood, although their share of fuel wood output reached 50 percent. The absence of statistics on these decentralized loggers in an important limitation on the usefulness of the handbook, for it is known that these enterprises are generally less efficient than similar enterprises of the timber ministry. The ministry has recently been abolished in line with a general decentralization of industrial administration inaugurated in 1957. Apparently, ministerial enterprises have been transferred to the more than 100 regional economic councils established throughout the USSR.

A breakdown of the types of wood logged by ministerial enterprises is provided in Table 4. An interesting feature of the data is the stability of the relative shares over a period spanning 15 years of violent war and vigorous postwar construction. The share going to pit props is a striking exception, illustrating postwar emphasis on mining development. No indication is provided in the handbook of the types of wood produced by self-suppliers or farmers.

The production increases of the timber ministry have resulted from additions to the logging labor force and increased mechanization. In the 1930's, and again in the early postwar recovery of logging output, primary dependence was placed on labor. Since about 1950, however, greater reliance has been placed on increased use of machinery and equipment. This policy is shown by capital investments in the timber ministry, indicated in Table 5.

If the figures have been adequately adjusted for price changes by Soviet statisticians they presumably reflect substantial real increases in the quantity of plant and equipment made available to the timber industry, the bulk of which went to logging. Evidently, Soviet planners were determined to improve the supply of logs *viz a viz* timber processing capacity (mainly sawmilling) where, it has often been reported, idle capacity has been caused by log shortages. A concrete indication of the meaning of this investment is provided by figures on the actual equipment in the hands of the ministry on January 1, 1957:

Electric saws	136,516
Gasoline saws	15,832
Electric branchers	22,960
Mobile electric generators	18,055
Winches	7,678
Tractors	28,358
Trucks	31,958
Narrow-gauge steam locomotives	1,948
Narrow-gauge motor locomotives	1,345

The total number of wage and salary workers in factory-plant enterprises of the timber ministry increased from 114,450 in 1950 to 163,180 in 1955, and for wage earners in logging from 639,400 to 677,200. Inasmuch as the bulk of logging is carried out during the period from September to March, when ice or snow traction is available, the meaning of these figures is much in doubt. It is claimed that the number of "permanent" wage earners in forest exploitation (excluding naval stores operations) rose from 460,200 to 710,700 over the period 1950-1955. This work force suffered in fact from a high rate of turnover. In the logging season 1954-1955 (nine months), 209,000 wage earners were recruited for "permanent cadre" in logging and floating within the timber ministry while, in the same period, 205,000 wage earners quit their jobs. Each figure represents about one-third of the total number of permanent wage earners in that year.[4]

Perhaps labor turnover is one reason explaining the remarkably unchanged level of productivity in logging during the postwar period in the face of increased use of machinery and equipment. Limitations on the labor supply resulting from war-time losses and disruption of the birth rate are beginning to press on Soviet industry. One method of overcoming a labor shortage is increased use of mechanization. This course was adopted

[4]*Pravda* (Truth), February 22, 1956.

for logging in the postwar period, but the results have proved disappointing. Average daily productivity of all personnel in logging enterprises of the ministry increased by 33 percent over the period 1950-1955. While this increase appears impressive, Soviet planners do not consider it to be so, and for good reason. According to the handbook, output per man-day was 0.87 cubic meters in 1940, 0.70 in 1945, 0.69 in 1950, and 0.92 in 1955. Thus, in 1955, after large investments had been made in the logging industry, productivity was only about six percent above the level in 1940, a year in which only a handful of equipment was in use.

There are many possible explanations of this fact, but perhaps the most important relates to the low priority granted immediate development of the logging industry. In 1950 a regulation was passed requiring prompt and complete disposal of slash. The consequence has been the diversion of large numbers of workers into this operation with the resultant depressive effect on average productivity. Soviet planners utilize many of the workers available from agriculture on a seasonal basis to aid in natural regeneration of cut-over areas. Such workers could be diverted to production, but this would necessarily be accompanied by additional investment in the industry, especially transportation, and such a shift of resources would not be consistent with the low priority given at present to increasing wood production.

Generally speaking, the handbook is welcomed by persons interested in the Soviet timber industry. At long last, many figures have been published in one text, whereas up to this time, with minor exceptions, fruitful research in this field called for the piecing together of literally dozens of scraps of information gleaned from as many Soviet periodicals and monographs.

The handbook illustrates a fact which students of the Soviet economy have long been aware of, namely, that Soviet writers in many cases simply do not discuss publicly questions in which Western students have an interest. Foreign trade in wood products is left untouched, although this is discussed in a foreign trade handbook. Pricing of wood products and the policy on stumpage fees are not examined, although such information would enable evaluation of the timber industry as a branch of the Soviet economy. The omission of data on self-suppliers and agriculture has already been noted. No mention is made, understandably, of the role of "forced labor" in logging, although there is evidence in Soviet literature that such labor was important in logging before the war and existed after the war. No data are provided on total or regional forest growth, nor is the quality of the forests indicated (size of trees, condition, etc.). The subject of production costs is dismissed in three pages, and no absolute figures on cost are presented. Similarly, a single figure is provided for various years on labor productivity in the entire factory-plant branch of the timber ministry.

In brief, much important information remains undisclosed. Add to this the fact that Soviet statistical concepts used in the handbook are not defined for the most part, and the limitations of the handbook become clear. The handbook must be approached gingerly, and used with great selectivity, if the reader is to avoid the many statistical pitfalls and booby traps contained therein. If this is done, meaningful results may be obtained, and our knowledge of the Soviet timber industry advanced.

TABLE 4.—OUTPUT (*Vyvozka*) OF TIMBER BY THE TIMBER MINISTRY, SELECTED YEARS, 1940-1955
(in millions of cubic meters and percent)[1]

End use	1940	1945	1950	1955
Total (million cu. m.)	65,858	33,348	96,856	124,276
		Percent of total		
Sawlogs	44.4	37.0	40.6	41.4
Construction timbers	16.7	8.0	15.8	13.6
Ship & hydro-technical	1.2	1.1	2.5	1.9
Telegraph poles	0.9	0.4	1.0	1.1
Special poles	0.6	[2]	0.2	0.3
Pulpwood	7.5	7.1	7.5	8.1
Pit props	9.0	28.4	14.3	16.7
Sleepers	9.7	11.6	11.1	8.0
Veneer	2.2	1.7	1.6	2.1
Match bolts	0.8	0.8	0.9	0.7
Other	7.0	3.9	4.5	6.1

[1] *Timber Handbook*. Op. cit. p. 102. Absolute figures differ from those cited as industrial wood production of the ministry in Table 2. Apparently, a coefficient has been applied to the data to adjust it for qualitative or other variations in aggregate output. At any rate, precentage figures remain a fair indication of the breakdown of total production.

[2] Not available.

TABLE 5.—INVESTMENT IN THE TIMBER MINISTRY, SELECTED YEARS
(In millions of rubles and prices as of July 1, 1955)[1]

	Logging		Sawmilling-Woodworking	
	Millions of rubles	1940=100	Millions of rubles	1940=100
1940	412	100	87	100
1946	331	80	52	60
1950	1,697	410	130	149
1955	3,044	740	379	440

[1] *Timber Handbook*. Op. cit. p. 190. The official rate of exchange (1 ruble=$0.25, or 4:1) is not an adequate guide for establishing the meaning of these figures in dollar values because the ruble is over-valued generally speaking.

Exposure of Longleaf Pine Planting Stock[1]

G. K. Slocum and T. E. Maki

LONGLEAF PINE (*Pinus palustris* Mill.) has earned a reputation over the years as being a species difficult to plant. One of the factors believed to contribute occasionally to excessive initial mortality is the fortuitous exposure of roots to direct sunlight. Such exposure invariably occurs to a greater or lesser degree in the several operations from lifting through planting. In machine operations, especially, this type of exposure may well be of sufficient duration to reduce survival by a significant amount.

Although early studies by Wakeley[2] have shown that exposure of longleaf seedlings to direct sunlight up to 20 minutes "had little significant or consistent effect on survival," it was deemed desirable to investigate this problem further, assessing particularly exposure effects on puddled roots, since studies by Slocum and Maki[3] had demonstrated striking benefits from puddling of loblolly pine. Accordingly, a study was undertaken in the spring of 1954 to test the effect of direct exposure on both bare-rooted and mud-coated roots of longleaf pine planting stock.

Experimental Procedure

Two separate tests were conducted as a part of this study, the first being an exploratory one undertaken in the spring of 1954.

In the first test "bed-run" 1-0 longleaf pine seedlings[4] were graded to uniform size, then assembled into 40 bundles, each comprising 10 seedlings. Half of these bundles were drawn at random and immersed up to the root collars in clay mud of the consistency of medium-thick gravy; next, five bundles from each half were drawn at random and heeled into moist soil without any exposure. The remaining 30 bundles (15 with mud-covered roots, and 15 with bare roots) were set out quickly on an elevated plank (with roots of each bundle extending freely beyond the edge of the plank to facilitate drying) and exposed to full sunlight for periods ranging from a minimum of 30 minutes to a maximum of two hours.

This exposure treatment was administered on March 25, 1954, in the afternoon between 3:30 and 5:30 p.m., with temperature averaging 80°F., wind velocity 22 miles per hour, and relative humidity 42 percent. The actual procedure consisted of drawing at random five bare-rooted and five mud-puddled bundles at intervals of 30 minutes and rapidly heeling them into moist soil, so that for the entire experiment, one-fourth of the stock received no exposure; one-fourth was exposed for 30 minutes; another for 60 minutes; and the remaining fourth for 120 minutes.

The seedlings were planted into prepared soil in the School of Forestry Nursery in Raleigh on April 1, after seven days in the heel-in bed. The day was cool and bright, the planting done between 9:45 a.m. and noon, and the soil was a fairly uniform sandy loam with silt plus clay content ranging from about 25 percent to about 40 percent.

The design of the experiment was a randomized complete block, with eight treatments (all possible combinations of four exposure times and two root conditions) assigned at random by rows within blocks which were replicated five times.

Records were kept of mortality periodically throughout the growing season to chart the rate of seedling deaths in the several treatments.

Since the results of the first test showed comparatively light mortality somewhat erratic in pattern, it was deemed desirable to repeat the test the following spring, including both large and small stock and a longer period of exposure. Accordingly, a test was undertaken in March 1955, using 1-0 longleaf seedlings grown in the School of Forestry Nursery at Raleigh from seed collected from the Carolina Sandhills region and furnished by the N. C. State Division of Forestry. The seedlings were lifted and graded on March 5, 1955, and exposed on March 11, after a period of six days in the heel-in bed, the procedure for random bundle selection, puddling and exposing being the same as in the previous test. Exposure was undertaken at 11:00 a.m. in clear, windy weather when the temperature averaged 73°F.; wind velocity was 14 miles per hour, and relative humidity 54 percent. Exposure times were 0, 45 minutes, 90 minutes, and 180 minutes. The stock was planted the following day in prepared soil in the School of Forestry Nursery in the same manner as in the previous test, and periodic checks were made throughout the growing season to chart the course of mortality in the several treatments.

At the time of grading, extra bundles were assembled beyond those needed for planting, and one bundle per treatment was drawn at random to provide a basis for

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[1]Contribution from the School of Forestry, N. C. Agricultural Experiment Station, Raleigh, N. C. Published with the approval of the Director of Research as Paper No. 1020 of the Journal Series.

[2]Wakeley, Philip C. Planting the southern pines. Agric. Monograph No. 18. Forest Service, U. S. Dept. Agric. pp. 233, illus., 1954.

[3]Slocum, G. K. and T. E. Maki. Exposure of loblolly pine planting stock. Jour. Forestry 54: 313-315. 1956.

[4]Grateful acknowledgement is made to the Clayton Nursery of the N. C. Division of Forestry in the Department of Conservation and Development for making stock available for this test.

assessment of size differences for the stock graded as "large" and that graded as "small." After measurements and green or fresh weights had been obtained, the seedlings were oven-dried to constant weight. The average seedling size by large and small classes per treatment or replication is indicated in the tabulation below:

Treat. or repli.	Lg. 1-0 longleaf seed Groundline diameter	Green wt.	Dry wt.
	mm	gr.	gr.
1	6.25	7.16	2.95
2	6.34	7.45	3.10
3	6.25	7.31	2.92
4	6.40	7.52	3.16
5	6.90	7.63	3.21
Mean	6.42	7.42	3.07
Treat. or repli.	Small 1-0 longleaf seed Groundline diameter	Green wt.	Dry wt.
	mm	gr.	gr.
1	4.10	3.58	1.51
2	3.90	3.49	1.44
3	3.60	3.02	1.22
4	4.10	3.56	1.51
5	3.75	3.18	1.28
Mean	3.89	3.35	1.39

The fresh weight/dry weight ratios were 0.414 for the large stock, 0.415 for the small stock, indicating that both classes were of about the same degree of succulence.

Results

In the first exploratory test, the results, as previously mentioned, showed relatively light mortality for all degrees of exposure. Nevertheless, the mortality was approximately twice as heavy for bare-rooted stock as for stock with mud-covered roots (Table 1), the mean difference of 10.5 percent being significant at the one percent level. Sixty-one of the 400 seedlings, or 15.25 percent of the total, died in the first growing season. Over 40 percent of this mortality had occurred by June 1, almost 75 percent by July 5, and approximately 93 percent by September 17. Average survival showed a gradual downward trend with increasing exposure, which, however, failed to attain significance at the one percent level. The interaction of exposure with root condition almost attained significance at the five percent level (Table 1).

In the second test, involving both large and small stock, the trend in mortality, or its complement, survival, was somewhat more uniform than in the exploratory test reported in Table 1. Root condition, size of stock, and duration of exposure were all highly significant sources of variation, but none of the interactions was significant. The average survival of bare-rooted stock was 33.4 percent, that of stock with mud-covered roots 58.8 percent, the difference being significant on the one percent level (Table 2). The mud coating was clearly beneficial, reducing mortality for all durations of exposure. In this test, as in the earlier loblolly test,[3] the puddling treatment appeared to be beneficial even for the stock that was not deliberately exposed; however, in the 1954 test (Table 1) this benefit was not evident.

The large stock was clearly superior, the average absolute difference of over twenty-two percent being significant beyond the one percent level.

TABLE 1.—AVERAGE PERCENTAGE FIRST-YEAR SURVIVAL OF 1-0 LONGLEAF PINE BARE-ROOTED AND PUDDLED PLANTING STOCK FOR DIFFERENT DURATIONS OF EXPOSURE. PLANTED APRIL 1, 1954; FINAL TALLY MADE DECEMBER 4, 1954. BASIS: 50 SEEDLINGS PER MEAN

Root condition	Duration of Exposure—Minutes 0	30	60	120	Mean of all exposures
	pct.	pct.	pct.	pct.	pct.
Bare	96	78	78	66	79.5
Mud-coated	88	98	92	82	90.0
Mean	92	88	85	74	84.75

L. S. D. for exposure means = 12.7% at the 0.05 level.
L. S. D. for exposure × root condition means = 15.0% at the 0.01 level.

Discussion

The failure of the 1954 and the 1955 tests to be in close concordance, so far as level of survival is concerned, emphasizes the large effect that source of stock and growing season may have on the outcome. Neither the seed source nor the nursery regimen under which the seedlings grew to 1-0 stage was the same for these tests, although all other conditions were identical, except vagaries of weather.

Actually, the weather in the critical period from March through May, inclusive, appeared somewhat more severe for the 1955 season, as indicated in Table 3.

The total growing season from March to October, inclusive, however, appeared to be no worse in 1955 than in 1954.

Since small seedlings were not included in the 1954 test, a reasonable comparison of performance can be made only between the large stock of the 1955 test with the stock used in the previous year. It is interesting to note then that even after 120 minutes of exposure, the 1954 stock survived much better than the 1955 large stock that was exposed only 90 minutes (82% vs. 47.5%).

Despite this lack of concordance, it is clear that the clay-puddling of longleaf pine roots is very beneficial, though not so striking as was observed in previous tests on loblolly pine.[3] Wakeley's[2] study on exposure of bare-rooted longleaf and slash pines showed that after 5-1/3 hours, survival dropped to six percent. In this study, extrapolation of the mortality curves suggests that for all bare-rooted stock and also for puddled small stock, survival would have reached zero well within an exposure of five hours. However, the trend of mortality in the large puddled stock suggests that even after five or six hours of exposure, the survival might still have been forty percent or greater.

This study again emphasizes the superiority of large longleaf pine planting stock, the advantages of which have been clearly demon-

strated in other studies.[5] To obtain acceptable field survival, longleaf should be grown at sufficiently low densities in the nursery beds to insure uniform development of groundline diameters of no less than six to seven millimeters or about one-fourth inch.

Obviously, there is no virtue in deliberate exposure of roots, but some exposure invariably occurs both at lifting and at planting time, perhaps more so in machine than in hand tool operations. Should such exposure occur under any circumstances, it is worthwhile to know how much it contributes to subsequent mortality of the planted stock. This study indicates that with proper-size stock and clay-puddled roots, exposures up to about 30 minutes can be tolerated with impunity, and accidental exposure even past this duration should not give cause for panic. Puddling appears as a relatively inexpensive and simple insurance against the harmful effects of chance exposure of longleaf roots during planting operations.

Summary and Conclusions

One-year-old longleaf pine planting stock was exposed to direct sunlight in two tests in 1954 and 1955 at Raleigh, North Carolina. Half the stock had the roots puddled in creamy clay mud prior to exposure; the remainder was handled according to normal practice, leaving the roots bare. Average temperatures during exposure ranged from 73°F. to 80°F. The seedlings were planted in randomized replicated blocks in prepared soil in the nursery and the trend of survival was tallied during the first growing season. The following conclusions appear warranted on the basis of these tests:

1. Large stock (averaging ¼ inch in groundline diameter and weighing over three gr. when oven dry) is clearly superior to small stock (averaging ⅛ to 3/16 inch in diameter and weighing less than 1½ gr. when oven-dry) in withstanding direct exposure.

2. Almost any duration of exposure is probably harmful, but with larger stock and clay-puddled roots, first-year survival remains acceptable up to half-hour or longer exposures. Even after three hours, survival of large stock averaged more than fifty percent at the end of the first growing season.

3. Clay-puddling of longleaf pine roots after lifting and grading appears to be a simple and inexpensive guard against injury from chance exposure during planting.

TABLE 2.—AVERAGE FIRST-YEAR SURVIVAL PERCENT OF BARE-ROOTED AND PUDDLED LARGE AND SMALL 1-0 LONGLEAF PINE PLANTING STOCK SUBJECTED TO DIFFERENT DURATIONS OF DIRECT EXPOSURE TO SUNLIGHT ON MARCH 11, 1955. BASIS: 40 SEEDLINGS PER INDIVIDUAL MEAN

Dur. of exp.	Large Stock			Small Stock			Both Sizes		
	Bare roots	Pudd. roots	Both	Bare roots	Pudd. roots	Both	Bare roots	Pudd. roots	Both
Min.	*Percent*								
0	70.0	92.5	81.2	70.0	67.5	68.8	70.0	80.0	75.0
45	55.0	80.0	67.5	12.5	55.0	33.8	33.8	67.5	56.0
90	30.0	65.0	47.5	15.0	42.5	28.8	22.5	53.8	38.2
180	12.5	55.0	33.8	2.5	12.5	7.5	7.5	33.8	20.6
All dur.	41.9	73.1	57.5	25.0	44.4	34.7	33.4	58.8	46.1

L. S. D. for exposure means: 12.9% at 0.05 level
17.3% at 0.01 level

TABLE 3.—WEATHER DURING CRITICAL PERIOD, 1954 AND 1955

	Temperatures					Days with trace or more of rain
	Ave. max.	Ave. min.	Ave. mean	Total evap.	Total precip.	
	°F.	°F.	°F.	ins.	ins.	No.
March-May, 1954, inc.	85.7	30.3	58.7	16.32	10.97	47
March-May, 1955, inc.	87.7	33.0	62.1	17.60	6.21	46
March-Oct., 1954, inc.	95.1	41.2	68.1	53.34	27.79	108
March-Oct., 1955, inc.	90.4	48.0	68.4	46.67	31.50	122

[5] Cf., for example, Johansen, R. W., the effects of certain nursery treatments and site preparation on the vigor and survival of longleaf pine (*Pinus palustris* Mill.) in the deep sands of the Carolinas. Master of Science Thesis, School of Forestry, N. C. State College, Raleigh, 1955; and Hatcher, John B. Prescription planting. Forest Farmer 16(5):4-6. February, 957.

The Effect of Rootstock Activity on the Success of Fall Grafting of Spruce

Hans Nienstaedt

ALTHOUGH FALL GRAFTING of spruce often has been recommended (*6*, *10*), it has been shown that late winter grafting in the greenhouse and early summer field grafting on active plants give much better results (*2*, *11*, *13*). However, a dependable method of grafting during the month of September would be convenient for the tree breeder who, in many cases, would be able to combine seed and scion collection and do the grafting in an otherwise slack season. Improved fall grafting techniques are therefore needed.

Success of grafting depends on (1) the promptness of union formation and (2) the amount of drying to which the scions are exposed between the time of grafting and formation of a good union. Promptness of union formation depends on the amount of growth activity of the plant parts; it probably is safe to generalize by saying that the greater the activity of the rootstock, the faster the plant parts will be joined. Conversely (except in soft tissue grafting), a great amount of activity in the scion at the time of grafting or immediately thereafter is not desirable as it will cause a high degree of evaporation from the scion unless special precautionary measures are taken. However, the scion does sometimes contribute to callus formation (*7*), and its activity should therefore not be unduly delayed.

Reported here are the results of a study in which the growth activities of Norway spruce (*Picea abies* [L.] Karst.) and white spruce (*Picea glauca* [Moench] Voss) rootstock and white spruce scions were controlled by photoperiodic and chilling treatments; marked effects on both the success of grafting and graft behavior resulted. Some observations on the interaction between photoperiod and chilling on the breaking of bud dormancy were also made.

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Method of Study

The most vigorous 2-year-old seedlings of white spruce and Norway spruce were selected in the nursery beds and planted in 4-inch pots during the latter part of May, 1956.

Rootstock treatments were begun on June 27, when part of the plants were moved to a lightproof

Fig. 1.—Veneer side graft of white spruce scion on white spruce rootstock. The rootstock was pretreated with long day (*L*) and the graft treated with long day (*l*). Picture was taken on April 12, 7 months after grafting; the scion has just resumed growth. Similar plants, which were chilled for 8 weeks beginning November 1, began growing 3 weeks after they were returned to the greenhouse.

shed. Treatments were as follows:

L (for long day): 20-hour photoperiods from June 27 until September 11. The light source was a combination of "daylight" fluorescent tubes and incandescent bulbs. Long photoperiods cause an extension of the period of growth of most tree species. It was therefore expected that this treatment would maintain the plants in a growing condition until the time of grafting in September.

F (for field conditions): The plants remained in the nursery bed under partial shade and had reached the normal rest condition by September 11. These seedlings were not exposed to natural chilling in the field. They were therefore expected to require artificial chilling in order to resume growth.

C (for chilling): 13-hour photoperiods at normal outdoor temperature from June 27 to July 12 followed by chilling at 41° F. from July 12 until September 11. The photoperiod remained unchanged during the period of chilling. The short photoperiod was expected to bring the plants into a dormant condition, while the subsequent 8 weeks of chilling was thought sufficient to fulfill the plants' chilling requirements, permitting rapid resumption of growth upon return to the greenhouse.

S (for short day): 13-hour photoperiods from June 27 until September 11. It was expected that these plants would be dormant at the time of grafting and would be unable to resume growth immediately because of lack of chilling.

Throughout the treatments the plants were carefully watered in order to maintain them in the best possible growing condition.

The plants were grafted on September 11-14, 1956, using the graft known as the veneer or the veneer side graft; the graft union was placed 3 to 6 inches above the soil

line, but below the crown of the seedlings (Fig. 1). Scions were from the lower third of the crown of approximately 30-year-old white spruce trees. The grafts were waxed and left on the open benches in the greenhouse for further treatment. Ten grafts on each rootstock were exposed to each of the 17 treatment combinations.

After grafting, all but 80 grafts —40 of each rootstock species— were exposed to a 20-hour photoperiod in the greenhouse. The remaining 80 plants were placed on a 13-hour photoperiod (treatment *s* below). On October 15, the plants were again divided and placed under the following treatments:

l (for long day): 20-hour photoperiods.

cn (for chilling and normal daylight): 13-hour photoperiods from October 15 until October 31; chilling at 41° F. from October 31 until April 1, 1957, and then normal greenhouse conditions.

cs (for chilling and short day): 13-hour photoperiods from October 15 until October 31; chilling[2] at 41° F. from October 31 until January 2, 1957, and then 13-hour photoperiods in the greenhouse.

cl (for chilling and long day): Same as above treatment except the plants were exposed to a 20-hour photoperiod in the greenhouse after the chilling period.

s (for short day): Unaltered 13-hour photoperiods in the greenhouse.

The plants remained under treatment until early June 1957, when they were moved into the field.

The rootstock was cut back gradually beginning October 31, when the leader and a few of the first side branches were removed. Not until the scions had completed one season's growth were the stocks completely cut back. The grafts were examined at intervals during the months following grafting and the number of live grafts and the growth condition of the stock as well as scion recorded. After the scions had terminated growth, the length of their longest new shoot was recorded.

[2]Thirteen-hour photoperiods were used during chilling treatment except for *cn* grafts over which it was impossible to use lights.

TABLE 1.—PERCENTAGE SURVIVAL ON JULY 29, 1957, OF WHITE SPRUCE GRAFTS MADE SEPTEMBER 1956, ON WHITE SPRUCE AND NORWAY SPRUCE ROOTSTOCK

Treatment after grafting	Stock plant species	Percentage survival of grafts when pretreatment was— *L* 20-hour day	*F* Field conditions	*C* Chilling 8 weeks	*S* 13-hour day	Average by species	Average by treatment
l (20-hour day)	NS	90.0	70.0	90.0	100.0	87.5	87.5
	WS	90.0	80.0	90.0	90.0	87.5	
cn (chilling for 5 months, then normal greenhouse)[1]	NS	80.0	60.0	90.0	.....	76.7	66.7
	WS	40.0	100.0	30.0	.....	56.7	
cs (chilling for 2 months, then 13-hour day in greenhouse)[1]	NS	80.0	100.0	80.0	.....	86.7	80.0
	WS	70.0	80.0	70.0	.....	73.3	
cl (chilling for 2 months, then 20-hour day in greenhouse)[1]	NS	66.7	70.0	90.0	.....	75.9	79.3
	WS	77.8	80.0	90.0	.....	82.8	
s (13-hour day)	NS	80.0	80.0[2]	90.0	66.7[2]	79.5	68.5
	WS	30.0	80.0[2]	40.0	80.0[2]	57.5	
Average by species	NS	79.6	76.0	88.0	84.2	.....	.....
	WS	61.2	84.0	64.0	85.0	.....	.....
Average by treatment	Both combined	70.4	80.0	76.0	84.6	.....	76.5

[1]Chilling was preceded by 13-hour photoperiods for 2 weeks.
[2]Measurements for these treatments were made on May 28.

Results and Discussion

When the final survival count was made July 29, 1957, 76.5 percent of the grafts were alive. This is a high percentage considering that several of the treatments were expected to have an adverse effect; it compares well with the results reported by Holst, Santon, and Yeatman (*4*).

TABLE 2.—PERCENTAGE ROOTSTOCK PLANTS OF WHITE SPRUCE AND NORWAY SPRUCE SHOWING ACTIVE GROWTH AT DIFFERENT DATES DURING THE EXPERIMENT

Treatment after grafting	Stock plant species	Percentage showing active growth[1] when pretreatment was— *L* 20-hour day 10/5	10/31	2/15	*F* Field conditions 10/5	10/31	2/15	*C* Chilling 8 weeks 10/15	10/31	2/15	*S* 13-hour day 10/5	10/31	2/15
l (20-hour day)	NS	70	90	78	0	0	100	0	80	80	0	30	89
	WS	30	0	33	0	0	67	10	70	60	0	30	56
cn (chilling for 5 months, then normal greenhouse)	NS	70	90	0	0	0	0	0	80	0			
	WS	10	0	0	0	0	0	30	70	0			
cs (chilling for 2 months, then 13-hour day in greenhouse)	NS	60	90	100	0	0	100	0	80	100			
	WS	40	0	87	0	0	100	30	30	89			
cl (chilling for 2 months, then 20-hour day in greenhouse)	NS	67	67	56	0	0	100	0	30	100			
	WS	50	0	86	0	0	100	10	50	100			
s (13-hour day)	NS	70	0	0	0	0	0	0	0	0	0	0	0
	WS	60	0	0	0	0	0	0	0	0	0	0	0

[1]Shown as percent of the number of plants surviving at the time of the count.

Graft survival (Table 1) was little affected either by the treatment of the rootstock prior to grafting or the treatment of the graft except for treatment combinations *L-cn, C-cn, L-s, and C-s*. In these cases the grafts on white spruce rootstock survived with only 30 and 40 percent compared with the 70 to 100 percent obtained with the other treatments. The white spruce rootstocks were badly damaged by treatment *cn* and were almost completely defoliated shortly after they were moved back to the greenhouse. Norway spruce rootstocks were much less damaged, which may explain the better survival of the grafts. In treatment *L-s* the sudden change from long- to short-day conditions probably accounts for the poor results in white spruce; similarly, short-day conditions completely failed to activate the plants in treatment *C-s* —hence the low "take".

Rootstock behavior (Table 2) followed the expected pattern as outlined in the description of pretreatments. Some stock plants (*L*) were active at the time of grafting; some were dormant (*F*) and remained in that condition; and some were dormant (*C*), but resumed growth shortly after grafting. Graft survival showed no uniform response pattern dependent on these treatment effects, and it must, therefore, be concluded that under the conditions of the experiment, rootstock activity during the first 6 weeks had little or no effect on the success of grafting.

The difference in the response of the two rootstock species was striking. Norway spruce terminates growth later than white spruce (pretreatment *L*); while white spruce appears to resume growth more rapidly after a rest and chilling period (pretreatment *C*, Oct. 5). This latter observation was reported earlier by Holst (*3*), who ascribed the difference to adaptation to different temperature conditions in the spring.

Holst explained the observations he made on the basis of temperature only. However, photoperiod may enter the problem, since it is known that photoperiod compensates for lack of chilling in some species (*8, 9, 12*). Spruce also will break dormancy on long photoperiods in spite of lack of chilling, but not on short photoperiods (treatments *l* and *s*). Norway spruce, however, responds more promptly and more uniformly than white spruce. This is shown in the difference between the two species in treatments *L-l*, *F-l*, and *S-l* (Table 2). The table, however, does not show the pattern of development; the majority of buds will flush in Norway spruce while only a few scattered buds will open on white spruce; these same responses of the two species have been reported by Holst, Santon, and Yeatman (*4*).

Scion growth under the different treatments is shown in Table 3. The difference between the chilled (treatments *cn*, *cs*, and *cl*) and nonchilled grafts (treatments *l* and *s*) is again very striking, as is the difference between the grafts growing on short day and those growing on long day. Nonchilled scions never did break dormancy on short day (treatment *s*), with the exception of 2 out of 54 plants living at the end of the experiment. On long day (treatment *l*), on the other hand, 73 percent of the surviving grafts had grown actively by the time the experiment was completed.

Flushing on nonchilled stock (treatment *l*), however, was much delayed; the first sign of flushing was noticed in the middle of March, as opposed to the chilled plants on which the scions began showing signs of activity 3 weeks after they were removed from the chilling conditions to the greenhouse. Of the chilled grafts surviving, 96 percent had grown by the end of the experiment, but no effects of photoperiod or rootstock species were evident.

The lack of difference between the results with the two rootstock species in scion behavior was general throughout the experiment except on the unchilled plants which were exposed to long photoperiods (treatment *l*). Of these, only 56

TABLE 3.—AVERAGE GROWTH DURING ONE SEASON OF WHITE SPRUCE SCIONS ON WHITE SPRUCE AND NORWAY SPRUCE ROOTSTOCK

Treatment after grafting	Stock plant species	Average growth of scions when pretreatment was— *L* 20-hour day	*F* Field conditions	*C* Chilling 8 weeks	*S* 13-hour day	Treatment average
		Centimeters				
l (20-hour day)	NS	4.56	3.56	3.29	3.10	3.62
	WS	4.06	3.47	3.15	3.81	
cn (chilling for 5 months, then normal greenhouse)	NS	7.36	6.80	6.49		6.84
	WS	5.55	7.53	6.24		
cs (chilling for 2 months, then 13-hour day in greenhouse)	NS	5.05	6.10	5.61		5.46
	WS	5.65	4.78	7.01		
cl (chilling for 2 months, then 20-hour day in greenhouse)	NS	5.81	6.17	7.27		6.60
	WS	7.39	6.07	6.49		
s (13-hour day)	NS	0	2.20	0	3.02	2.61
	WS	0	0	0	0	
Treatment average		5.77	5.53	5.80	3.31	

TABLE 4.—DIFFERENTIAL EFFECTS OF NORWAY SPRUCE AND WHITE SPRUCE ROOTSTOCK ON THE PERCENT OF WHITE SPRUCE SCIONS GROWING UNDER 20-HOUR PHOTOPERIOD

Rootstock species	Percent scions with new growth when pretreatment was— *L* 20-hour day	*F* Field conditions	*C* Chilling 8 weeks	*S* 13-hour day	Species average
Norway spruce	44	71	44	66	56
White spruce	78	100	100	78	89

percent of the grafts on Norway spruce rootstock grew while 89 percent grew when white spruce rootstock was used (Table 4). Undoubtedly, this is not an indication of incompatibility between rootstock and scion, as it is commonly recognized; it probably is a direct result of the greater growth activity of the Norway spruce rootstock—the development of the rootstock buds suppressing the growth of the lower scion bud.

Not only was the number of growing scions influenced by the treatments, but also the amount of growth was influenced markedly. Long day was distinctly better than short day on the chilled plants (treatments *cl* and *cs*, Table 3); the difference between 6.60 cm. and 5.46 cm. is highly significant ($t = 3.475$, d.f. 93, $P < .01$). This is the common growth response to photoperiod, which has been reported for numerous species.

The highly significant ($t = 3.751$, d.f. 85, $P < .01$) difference between treatments *cn* and *cs* may have been the result of either chilling or daylength differences or both. The plants were chilled for 3 months longer in treatment *cn* than in treatment *cs* and the natural daylength in the greenhouse in April soon exceeded the 13-hour photoperiod which the plants in treatment *cs* experienced when they began growing in January.

The growth of the unchilled scions on long day (treatment *l*) was much shorter than the growth of any of the chilled scions; it was even shorter than short day (*cs*). This again emphasizes the fact that although long photoperiods partly compensate for chilling, their effect is far from equal to it.

While the pretreatments of the rootstock had no differential effect on the growth of the chilled scions (treatments *cn*, *cs*, and *cl*), they may have had some effect on the unchilled scions (treatment *l*). Although further experiments are desirable, it appears that long day (*L*) is superior to chilling (*C*), ($t = 2.311$, d.f. 22, $P < .05$) and to short day (*S*), ($t = 2.304$, d.f. 22, $P < .05$); the difference between long day (*L*) and field conditions (*F*) also approaches significance ($t = 1.878$, d.f. 22, $.05 < P < .1$).

The physiology of dormancy and bud breaking is not well understood, and many theories have been advanced in attempts to explain the causes of dormancy and the effects of forcing agents (*1*). If the results with long day in the present experiment are accepted as a photoperiodic effect similar to flower initiation and the effects on growth, they would favor the theories which are based on the growth inhibitors and auxin in the plant (*5*); it is commonly accepted that photoperiodic stimuli involve a growth inhibitor-hormone system in the plant.

The results with nonchilled scions on long day (treatment *l*) are similar to those reported by Wareing (*12*) for *Pinus silvestris*; not only is bud breaking much delayed, but also the resulting growth is inferior. These are the responses encountered when the buds are allowed to become fully dormant in the fall before the long-day treatments are begun. Summer dormant buds, on the other hand, respond much more readily to long-day conditions and may show repeated new flushes of growth. Perhaps the fact that the rootstocks which had been exposed to long day (*L*) were still active or it least not fully dormant at the time of grafting, accounts for the greater amount of growth under treatment *L-l*. It is strange, however, that this rootstock effect which probably is auxin-like in nature affected the amount of growth without materially affecting the time of bud breaking. Additional experiments are needed to explain this interesting relationship between rootstock and scion.

Summary

By manipulating photoperiod and temperature, rootstocks of Norway spruce and white spruce varying in degree of activity were obtained. They were grafted in September with white spruce scions.

Graft survival was uniformly high, ranging from 70 to 100 percent and only in a few special cases did the rootstock treatments affect it.

Photoperiods and temperature treatments after grafting also failed to affect survival, but had considerable effect on scion activity and total growth.

The best postgrafting treatment was 4 weeks of long day followed by 2 weeks of short day, then 8 weeks' chilling, and finally by long day. Repeating this cycle should make it possible to obtain at least two growth flushes of the grafts during a winter season in the greenhouse.

The response of the two rootstock species to both chilling and photoperiod differed considerably. Thus while chilled white spruce appears to break dormany more readily than does Norway spruce, the latter species responds more readily to the bud-breaking effects of long photoperiods.

Other aspects of dormancy and the growth of the experimental material were observed and have been discussed.

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A Method for Obtaining Soil-Sample Volumes in Stony Soils[1]

T. F. McLintock

IN THE COURSE of a recent study of soil properties in the spruce-fir region of Maine, it was necessary to take several hundred soil samples of known volume. These were needed for making determinations of bulk density, total pore space, and other values that are essential for describing and evaluating soil structure.

However, this forest region is blanketed with a rocky glacial till. Rock fragments of all sizes and shapes are mixed in the soil, often occupying as much as 40 percent of it. In addition, tree roots develop a characteristically dense, coarse, wide-spreading network, penetrating only to an average depth of 14 or 15 inches.

Here core samplers, which take a known volume of soil, are completely useless in 90 percent of the soils. It was obvious that some other soil-sampling technique had to be used. The alternative was some method in which the volume could be computed from the size of the hole left after the sample had been taken.

Methods Tested

Summaries by Curry (*2*) and Russell (*6*) suggested a number of techniques, three of which were carefully tested. These were the plaster cast method of Lutz (*5*), the viscous fluid method of Beckett (*1*), and the sand method of Frear and Erb (*3*). In all of these methods the soil sample was carefully taken by digging a small pit; and the volume was calculated from the known volume of material required to fill the pit. The tests were run in a moderately stony, compact, forest soil.

Plaster and Fluid Methods

These methods showed promise insofar as technique was concerned. But it was soon evident that both were unwieldy and impractical for field use where enough material and equipment for at least 12 or 15 samples had to be transported via knapsack into forest stands any distance from a road. The plaster cast method had the added disadvantage that the hardened blocks had to be carried back out again, along with the soil samples. The viscous fluid method was not attractive because it is very messy and requires great care and time to maintain any degree of accuracy.

Water has a number of fairly obvious advantages over oil or almost any fluid, viscous or not. One possible method using water was to insert a very thin sheet or bag of polyethylene into the soil hole, and fill the plastic container with water. This water could be used over again, so that only a small amount would have to be carried about.

This method, tried on a tentative basis, presented no technical problems; the plastic film was pressed tightly against the wall and bottom of the hole, and the weight of the water held it in place. However, repeated trials in the same hole gave sharply differing results. While some of these could be reduced, it was felt that, under the wide range of surface, soil, and light conditions encountered in the field, accuracy was too questionable.

Sand Method

As described by Frear and Erb (*3*) and Curry (*2*), with modifications as discussed below, the sand method was found to be accurate, consistent, and reasonably easy to carry out. It is similar in principle to the other two methods, but a known weight of sand is used to fill the excavation. A predetermined formula is used to convert sand weight to volume.

In adapting this method to large-scale field use, the first problem was to work out a basis for converting sand weight to volume. Since the space occupied by a given weight of sand is appreciably influenced by rate of pouring and by the size and shape of the container into which it is poured, a system was needed for uniformly settling or packing the sand particles. Laboratory tests showed that jarring a container filled with sand would reduce its apparent volume by as much as 18 percent.

Settling by jarring the container with the heel of the hand indicated that the volume became constant rather quickly. After being struck 20 times the reduction in volume

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[1]This report is based on studies the author made while serving at the Northeastern Forest Experiment Station's research center at Bangor, Maine.

practically ceased, irrespective of the size or shape of the container or the amount of sand used.

But soil pits dug in the ground cannot be jarred. However, after some trial and error it was found that by plunging a long, narrow bladed spatula up and down in the sand the same result could be accomplished. Most consistent values were obtained by half-filling the container, giving 30 strokes with the spatula, then filling and repeating. If more sand was needed, another 10 strokes were usually enough for final settling. Careful smoothing of the surface of the sand to conform with the soil surface completed the job.

Preliminary trials were next made with a series of glass beakers of known volumes, ranging from 450 to 1,150 milliliters. Each beaker was filled 10 times with dry sand that had been screened through a 2-millimeter sieve. The sand was packed in accordance with the procedure just described, and then weighed. Very consistent weight-volume relationships were obtained, indicating that a linear regression could be used for estimating volume.

The final stage was to test a series of sand samples by 100-gram classes, starting with 700 grams and running through 2,400 grams. The sand was poured into glass beakers and settled as mentioned. The surface was leveled and a very fine rubber band was put around the beaker at the upper surface of the sand. The sand was emptied and the beaker filled with water to the exact level of the rubber band, and the volume required to do this was recorded. Three trials were run on each weight class.

Analysis of variance showed an extremely high significance for regression. The correlation coefficient was virtually 1.00 and the variation in weight accounted for 99.96 percent of the variation in volume. The resulting regression equation was: $Y = 0.6626X - 27$, where Y = sand volume in milliliters, and X = sand weight in grams.

Field Trials

This technique was field tested against the cylinder method described by Lutz (*4*). The tests were made in five soils ranging from a light, porous sand to a tight hardpan, but all virtually free of stones. Duplicate samples were taken in each case. Bulk density was used for comparisons.

In light soils results were somewhat erratic; differences between replicates for the cylinder method were greater than differences between methods. In the medium and heavy soils replicates gave more consistent results, and there was close agreement between the two techniques. It was concluded that in stone-free soils with bulk density of 0.90 or better the sand pit method worked very well.

The test was then repeated in stony soils, at 10 locations, with three pits dug at each. At first the cylinder method was tried as a control but was soon given up as being impossible because of the large number of rock fragments. Insead, the plaster block and viscous liquid methods were used as checks. Results were comparable, with differences averaging less than 8 percent. Furthermore, differences between the two "check" techniques were as great as between the sand pit and the other methods. The sand pit method gave more consistent bulk-density values among replicates than the viscous fluid method and was a great deal simpler to use than either of the other two, for reasons already mentioned.

The Sample Pit

The collection of soil samples calls for very careful excavation of a small cylindrical pit. An adequite pit for this study was about 5 inches in depth and diameter and about 1 liter in volume. In the collection of the several hundred samples, actual volumes ranged from 500 to 2,000 milliliters.

As a preliminary to excavating the pit, the soil above the horizon to be sampled was carefully removed; special pains were taken not to pull up roots or otherwise disturb the soil beneath. When the desired soil zone was reached, the surface was smoothed out as flat and level as possible. It was usually desirable to clear and prepare an area two feet or more across.

Actual digging and collection of the sample was started with a small penknife blade. A little soil at a time was dug out and transferred to a paper bag. As the hole got deeper a spoon worked very well. It was, of course, essential that every bit of soil from the pit be retained.

The walls of the pit must be straight and smooth with no stones or roots projecting into the hole. When stones occurred in the side of the hole the walls had to be dug back until the stone could be removed. If a depression in the wall remained, the hole had to be enlarged to include all of the depression or pocket where the stone had been embedded. Of course the stone sometimes turned out to be too large and the hole had to be abandoned and a new one started.

As roots were encountered they were snipped off flush with the wall with a small, stout pair of pruning shears. Fine rootlets were cut with a small pair of scissors. The pieces of root were kept as part of the sample.

Insofar as possible the cylindrical shape of the hole was retained, though a somewhat irregular cross-section was of no great concern. The hole's essential features were smooth, vertical walls. The floor of the pit was scraped flat and smooth and free of loose soil particles.

When completed, the excavation was filled with sand, as described above. The sand was weighed to the nearest gram on a small triple-beam balance before it was poured into the hole.

Limitations and disadvantages.— The sand method has some limitations and disadvantages. For one thing, it is painstaking and slow. The first sample at any location, requiring the preparation of the site by careful removal of organic matter, roots, and upper soil

layers, usually takes an hour. However, subsequent samples at lower depths at the same site may only take half that time. Occurrence of large stones or roots may result in several false starts before a suitable location is found. A stone more than 4 inches across is ordinarily too large. This technique cannot be used in individual soil horizons less than 3 inches thick, or in areas of dense root concentration.

Some further words of caution are in order.

1. Accuracy is impaired by using damp sand. The sand should be kept in a dry place and in a closed container. This method should never be tried in rain, fog, or mist, or when water is dripping from the trees. Neither can it be used in wet soils.

2. In preliminary trials several kinds of sand were tested. No differences of any consequence showed up, but the sand to be used should always be given a quick test with containers of known volume prior to field work. Avoid very dusty sands.

3. A complete dry run involving all stages of this method should be made before starting a field program, and adjustments made if need be. All stages should be standardized insofar as possible. Even minor deviations, such as filling the pit only a quarter full before settling the sand, may give somewhat different results.

4. Best results were obtained with width and depth of pits about equal. Five inches seemed to be about right in this study.

5. Great care must be exercised in leveling the upper surface of the sand after the pit has been filled. It should not only be flush with the mineral soil at the edge of the hole, but also should conform with the natural slope of the immediate area and reproduce any irregularities that may have existed on the original soil surface. Of course, every effort should be made to make the soil surface as level and smooth as possible before the pit is dug.

6. About 75 percent of the sand can be reclaimed and used again (thus reducing the load to be carried) if a small, 2-millimeter sieve is carried along to screen the sand back into the container. But this should not be done if the sand is at all damp when it is spooned out of the pit.

Summary

It is believed that in the characteristically rock-strewn glacial tills of northern New England, the sand pit method of obtaining soil samples of known volume is superior to any other system in spite of its limitations.

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A Cruising Computer For Variable Plots, Tree Heights, and Slope Correction

Albert R. Stage

To APPLY variable plot cruising techniques accurately in brushy, steep terrain, a forester needs a ready means to check marginal trees. Larson and Hasel[1] found it was often easier to tape distances to doubtful trees than to use an optical device. They used a tape marked with limiting distance and corresponding slope correction for each diameter class. In northern Rocky Mountain forests, a prism or other angle-gage proved faster for all but difficult decisions. However, the combination of a prism and a marked tape may be undesirable because the plot radius is a continuous function of tree diameter with the former, and a stepwise function for the tape marked by diameter classes.

A new computer shown in Figure 1 expresses slope distance to boundary trees as a continuous function of tree diameter and slope angle. This device makes the combined use of prism and tape easier and more efficient. With it, the observer can rely on the prism or angle-gage for all but doubtful or obscured trees. For these trees, slope angle and tree diameter would be measured, the limiting slope distance[2] found from the slide rule, and the distance measured from plot center to tree to determine whether the tree is in or out of the "plot." Grosenbaugh[3] has demonstrated that bias due to trees of elliptical cross section can be minimized by using calipers to determine the tree diameter according to the formula: diameter $= \sqrt{D^2 + d^2}$ where D and d are the maximum and minimum diameters respectively.

The scales on this computer are also suited for finding tree height. These scales involve only a slight rearrangement of those on Haig's[4] circular slide rule for computing tree heights. Haig's height computer has been proved to be very efficient for research use in the northern Rocky Mountains over the last 30 years. Necessary data are: slope distance to tree, angle to tip of tree, and total angle (angle to tip ± angle to base of tree).

Tree height can be calculated with a single setting of the device. Other means of finding tree heights require horizontal distance in the calculations and at least one extra step prior to multiplying. The ease with which calculations are made on this slide rule makes it practical to work out each height as it is measured. Gross errors can then be

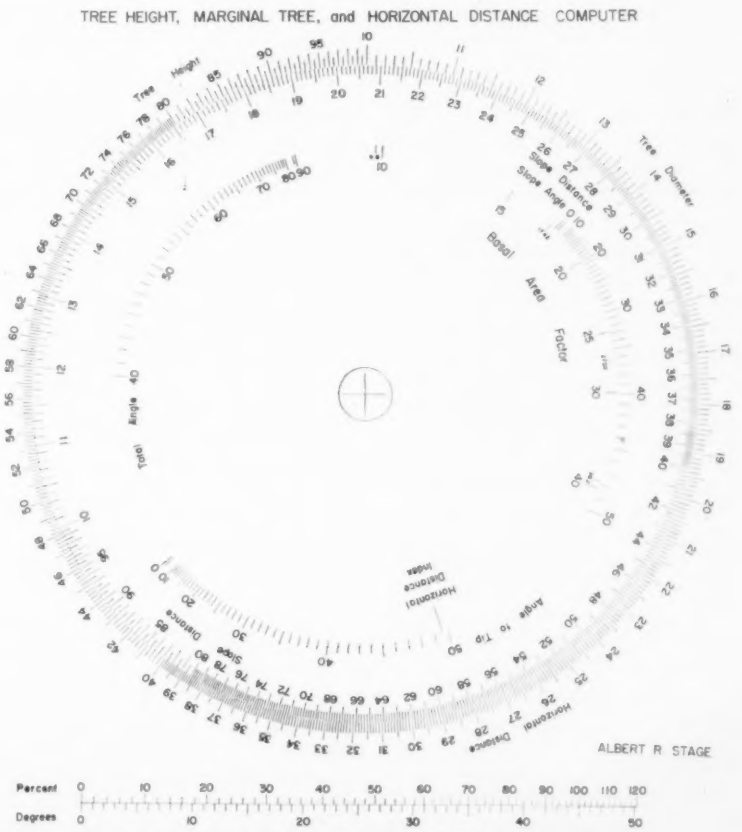

FIG. 1.—Tree height, marginal tree, and horizontal distance computer.

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[1]Larson, R. W., and A. A. Hasel. A field test of forest survey techniques. North Carolina Southern Piedmont Test, May 9, 1958, 44 pp. (Unpublished manuscript, Southeastern For. Expt. Sta., Forest Service, U. S. Dept. Agric., Asheville, N. C.)

[2]The computer solves the equation: slope distance

$$= \frac{\text{(Tree diameter) (Plot radius factor)}}{\text{(Cosine of slope angle)}}$$

[3]Grosenbaugh, L. R. Point-sampling and line sampling: probability theory, geometric implications, synthesis. Southern Forest Expt. Station Occasional Paper 160, 34 pp. 1958.

[4]Haig, I. T. Short cuts in measuring tree heights. Jour. Forestry 23:941-944. 1925.

TABLE 1.—PROBABLE ERRORS[1] IN HEIGHT MEASUREMENTS WITH AN ABNEY LEVEL ASSUMING A PROBABLE ERROR OF ONE-FOURTH DEGREE IN READING THE ANGLE

Angle to tip (degrees)	Slope of ground (angle to base in degrees)						
	+10	0	—10	—20	—30	—40	—50
				Percent			
10		3.6	1.7	1.1	0.8	0.6	0.5
20	3.7	1.8	1.1	0.8	0.6	0.5	0.4
30	1.9	1.2	0.8	0.6	0.5	0.4	0.3
40	1.4	1.0	0.8	0.6	0.6	0.5	0.5
50	1.3	1.1	0.9	0.9	0.8	0.8	0.8
60	1.7	1.6	1.6	1.5	1.5	1.5	1.6

[1]Computed from logarithmic tabular differences weighted for inherent decrease in precision of Abney levels with increasing angles, and for the fact that total angle represents the sum of two measurements subject to error. Heights are computed by law of sines.

immediately detected. On permanent sample plot work this is especially desirable.

Slope distances are also readily reduced to their horizontal equivalents with this slide rule. Or conversely, one can determine the amount to add for chaining in even units of horizontal distance.

With a degree arc on the Abney, one can more easily accomplish most tasks for which the percent and topographic scales were designed. Tree heights are more readily computed. Slope corrections are not limited to 1- or 2-chain intervals as with a trailer tape. A degree-percent conversion scale on the device is for work where slopes are read in percent (as in road location)

Two versions of the slide rule have been prepared: One for use in conjunction with a degree arc on an Abney (Fig. 1); the other modified for use with a percent Abney scale. Tree height computation is more tedious on the latter; otherwise they operate alike. The device consists of two sets of scales reproduced on dimensionally stable transparent sheets pivoted at their centers. The scales of the outer pair are logarithmic scales equivalent to the C and D scales on an ordinary 20-inch slide rule. These scales are continuous; that is, the graduation marked 10 can signify 1.0, 10.0, 100.0, etc. There are changes in frequency of graduations and numbering at 40 and 80. The inner scales are specially graduated to serve their particular purposes. The basal area factor scale is graduated at 10, 15, 20, 25, 30, and 40 square feet/acre/tree, and for 3, 4, 5, and 6 diopters.

Angular scales for computing height are limited to exclude angles to the tip of greater than 50 degrees, and total angles of less than 40 degrees. Geometric figures for other combinations of angles are not accurate enough for computing heights. Table 1 gives limits of error associated with a probable error of one-fourth degree in reading the Abney.

Mechanical error in assembling the computer can be held to less than 0.2 percent by making sure the circles in the center of each scale coincide and by interpolating between divisions of the scales.

How to Use the Computer

To check marginal trees.—First, determine slope angle or percent with an Abney level from prism or angle-gage to breast height on the tree in question. Then measure the diameter of the tree. On the slide rule set slope angle opposite the line for the proper basal-area factor. Then opposite tree diameter, read the limiting slope distance for that tree.[5] For example, Figure 1 shows the computer set at basal-area factor of 20 for a tree 20 degrees up or down slope. The limiting distance for a 14.0-inch tree reads 28.96 feet; for a 28.0-inch tree, 57.9 feet, etc.

To compute tree height.—Tree height is computed from angle to tip, total angle from the tip to base of the tree, and slope distance from Abney to base of tree. When the observer is uphill from the tree, the total angle equals the sum of the angle to tip plus the angle to the base. If the Abney is below the base of the tree, the total angle will be less than angle to the tip. On the computer with the degree arc set the angle to tip opposite the total angle; then opposite slope distance, read tree height on the outermost scale.

This procedure solves the law of sines with the assumption that the tree is vertical. If it is not, go at right angle to the direction of lean to introduce the least error.

The percent version of the slide rule may also be used to find tree height. First, convert slope distance to its horizontal equivalent as described in the next section. Then, place the "10" graduation on the outer edge of the movable scale opposite the horizontal distance on outermost scale. Read tree height on the outermost scale opposite the total percent (percent to the tip ± percent to the base) on the adjacent scale. This procedure is identical with the multiplication process on any slide rule.

To convert slope distance to horizontal distance.—Set slope angle or percent opposite the "horizontal distance index." Opposite the slope distance, read horizontal distance on the outermost scale.

How to Obtain the Cruising Computer

Film negatives of these circular slide rules are on file at the Intermountain Forest and Range Experiment Station. For use, positives are printed on 0.010-inch polyethylene base film and pivoted with a grommet. A number of both degree and percent computers have been assembled by the Intermountain Forest and Range Experiment Station for limited distribution.

[5]Conversely, this calculator can also be used to determine diameter at the 16-foot point on a tree according to the procedure suggested by Don Tandy and T. S. Kampmann, et al. Guides for variable plot cruising in Region 6. July 1, 1958, Portland, Ore. 28 pp. + appendix.

The Physiological Condition of Ponderosa Pine (Pinus ponderosa Laws.) Planting Stock as it Affects Survival After Cold Storage[1]

Edward C. Stone
and Gilbert H. Schubert

UNTIL RECENTLY all ponderosa pine seedlings planted in California were raised at either of two U. S. Forest Service nurseries—the Mt. Shasta and the Oakdale. At the Mt. Shasta Nursery, near McCloud, some seedlings have been dug each fall and placed in cold storage for early spring planting on the warmer low elevation sites; the remaining seedlings have been dug later in the spring. Further south at the Oakdale Nursery, where seedlings often begin top growth a month or more before planting sites are free of snow, all of the seedlings have been dug in early February and held in cold storage or "heeled-in" on the planting site until needed. Thus some stock from the Mt. Shasta Nursery has been stored 5 to 7 months and some has been freshly lifted, while all Oakdale stock has been stored or heeled-in 1 to 3 months.

Survival of seedlings from the Oakdale Nursery has generally been good; survival of seedlings from the Mt. Shasta Nursery has been variable—with failures almost as common as successes. Unfortunately field investigations of the inferential or correlative type have not furnished an answer. However, such studies do suggest that seedling deaths often occur before soil moisture is limiting and that under certain conditions high survival is possible.[2]

For a number of years forestry agencies have been concerned with the effect of storage on the subsequent survival of pine seedlings transplanted to the field. Numerous tests have been made but the results in general have not been published because they have been inconclusive. The few reports that have appeared indicate the uncertain status of cold storage as a forest nursery practice.

Hopkins (*6*) in New Hampshire lifted white pine (*Pinus strobus*) seedlings in the fall and held them in cold storage until the following July at which time he replanted them in the field. He concluded ". . . that stock cannot be held in cold storage successfully until so late."

Stoeckeler (*8*) in Wisconsin lifted white pine, jack pine (*P. banksiana*) and red pine (*P. resinosa*) during the first week of May and stored them at 50°F. up to 5 weeks before replanting in the nursery. Survival was 95 percent or higher for all storage periods, suggesting that storage was not harmful. However, on the basis of dry weight measurements made at the end of the growing season Stoeckeler concluded that ". . . late transplanting with or without cold storage has an adverse effect on growth and is accentuated by long storage."

Wakeley (*12*) in the Southeast reported that ". . . during 1934-35 through 1940-41 more than 15,000 seedlings, half longleaf (*P. palustris*) and half slash pine (*P. elliottii*) were stored in differently treated lots of 100 seedlings each, for various periods up to one month, in heel-ins, bales, tubs, and commercial cold storage . . . in an attempt to get practical answers to recurrent questions about stock storage." From these tests he concluded that heeling in or storing in Forest Service bales during the winter planting season was satisfactory up to a month, but cold storage at 35° to 41°F., in small sphagnum and burlap bales, gave erratic results, especially for periods of 3 to 13 weeks.

Baldwin (*1*) in New Hampshire lifted white pine and red pine seedlings in the fall and in the spring and subjected them to cold storage at different temperatures and for different periods of time. Although he did not present any specific data he concluded that cold storage at temperatures just above freezing was best and that ". . . fall storage resulted in lower survival than spring storage."

Fowells and Schubert (*5*) in California lifted ponderosa pine and Jeffrey pine (*P. jeffreyi*) seedlings in the fall and spring, subjected them to cold storage at 41°F. for 2, 4, and 6 weeks, and then replanted them in the field. They found that ". . . all the stock stored in the spring survived satisfactorily (87 to 100 percent). In contrast, the autumn-stored trees showed some decline in survival after 4 weeks' storage and serious decline after 6 weeks." Through additional tests they also concluded that 36°F. is close to the optimum storage temperature, that ponderosa pine could be safely stored for 3 to 6 months, and that the packing material affected the results.

Deffenbacher and Wright (*3*)

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[1]Work carried on as a joint project under University of California Agricultural Experiment Station Project 1577 and the Pacific Southwest Forest and Range Experiment Station of the U. S. Forest Service. Funds in support of this work were received in part from the California Division of Forestry and the U. S. Forest Service.

[2]Records on file in the Forest Management Division, Pacific Southwest Forest and Range Expt. Sta.

in Oregon lifted ponderosa pine seedlings in the fall and stored them at 35°F. up to 18 months before planting in the field. First year survival was 100 percent with stock that had up to 12 months of storage, but dropped off to 23 percent after 18 months. In another test comparing fall-lifted stock stored 6 months with fresh spring-lifted stock, survival was 96 percent or better in both cases. They concluded that ". . . if proper storage conditions are maintained, survival of trees is not impaired by storage up to six months."

Jacobson (*7*) in Sweden lifted Scotch pine (*P. silvestris*) seedlings in the fall and stored them over winter in the snow. He reported that survival was excellent when they were replanted the following spring.

Björkman (*2*), also in Sweden, lifted Scotch pine both in the fall and spring, and stored the stock at 30°F. up to 8 months before replanting in the field. He reported that spring-stored seedlings gave the best survival although the fall-stored seedlings stored well up to 5 months.

In these studies as well as in other unreported administrative studies, it is difficult to form generalized conclusions. Usually results cannot be compared because of variations in time of planting, methods, and species. Even small-scale controlled studies have not always given the same results with the same species, and attempts to duplicate techniques in large-scale field trials have generally been unsatisfactory.

Results of these stock-storage tests have all been evaluated on the basis of survival after field planting—mostly first-year-survival. Trees with green needles have been scored as living even though no new growth was evident. No attempt has been made to measure the physiological condition of the seedling before, during, or after cold storage. Consequently in some of these tests survival reflects the effect of a specific environment; in others, an altered seedling physiology. An interpretation is further complicated by a changing seedling physiology which varies from one month to the next, from one nursery to the next, and from one seed zone to the next (*9, 10, 11*).

Since storage has been an integral part of the nursery program in California, an evaluation of its effect upon seedling survival was considered necessary. As a first step, characterization of the effect of storage on the physiological condition of the seedling, as expressed by root development subsequent to transplanting, was undertaken. Although the study is not yet complete, since only fall storage has been examined, the data appear of sufficient interest to justify publication at this time.

Materials and Method

In brief the study consisted of digging seedlings from the nursery every 15 days, replanting them in the greenhouse after 0, 1, 2, and 3 months of cold storage, and redigging them 30 days later and recording any new root growth.

Two-year-old (1-1) ponderosa pine seedlings, representing four different seed collection zones and grown at the Mt. Shasta Nursery near McCloud, were used in the study. The four seed zones as described by Fowells (*4*) were: Zones II, the lower slopes, and III, the higher slopes of the northern westside of the Sierra Nevada; and Zones IV, the lower slopes, and V, the upper slopes of the southern westside of the Sierra Nevada.

Seedlings were dug on the 15th day of September, 1st and 15th days of October and November, and the 1st of December, packed in shingletow, and shipped by freight to Berkeley. There all the seedlings were root pruned to about 6 inches right after receipt, and, except for 20 seedlings of each shipment that were planted immediately, were repacked—ten per can—with their roots in moist vermiculite. Each of these cans was in turn sealed in a plastic bag and placed on a shelf in a 1°C. (34°F.) cold storage room, in which it was kept for either 1, 2, or 3 months.

Immediately upon receipt and again after 1, 2, and 3 months of cold storage, 20 root-pruned seedlings of each seedling shipment were subjected to the following treatment. First any white root tips that were evident were pinched off. Then the 20-seedling lot was planted—ten seedlings per galvanized container—in sand loam. These planted seedlings were then watered and drained, and the containers were placed in a 20°C. (68° F.) water bath in the greenhouse. After two weeks the seedlings were again watered and drained, and the containers were returned to the water bath for about two weeks more.

The air temperature in the greenhouse did not fall below 20°C. (68°F.) at night and with but few exceptions did not exceed 35°C. (95°F.) in the daytime. Thus the seedling roots were exposed to a constant temperature and an abundant supply of moisture and nutrients, and the tops to a varying air temperature and a changing photoperiod.

After one month in this greenhouse environment, each galvanized container was lifted from the water bath and the soil carefully washed from the seedlings. Only seedlings whose needles had turned completely brown and whose stems had dried and shriveled during their one-month stay in the greenhouse were judged dead and so recorded. The root systems of the remaining live seedlings were then examined and elongating laterals which had just started to suberize, but which could still be recognized as new roots, were counted.

Results and Conclusions

Seedling survival after storage improved after each two-week delay in lifting—until November 1. Thereafter there was no significant improvement (Fig. 1, Tables 1 and 2).

Each month of added storage significantly reduced survival. However, the reduction was most evident when the stock had been lifted before October 15 (Fig. 1 and Table 1). None of the stock lifted

September 15 and October 1 survived 3-month storage. In contrast, 82 percent survived when lifting was delayed until October 15, and 95 percent when lifting was delayed until November 1.

To some extent the seed collection zone influenced seedling survival after storage. Survival of Zones II and III seedlings was significantly lower than survival of Zone V seedlings. Here again, the effect was most evident when the stock was lifted before October 15 (Fig. 1 and Table 2).

When seedlings were lifted before November 1, the number of lateral roots that elongated following storage was significantly reduced by each month of additional storage. When lifted after November 1, the effect was not the same. Two months of storage clearly reduced the number of lateral roots that subsequently elongated, but an additional month of storage ap-

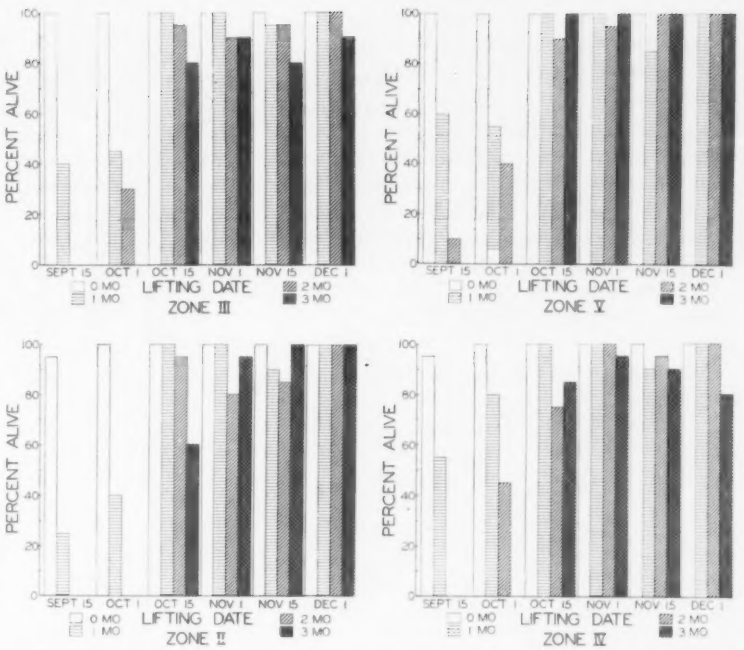

FIG. 1.—Survival of 1-1 ponderosa pine seedlings after one month in the greenhouse following cold storage.

TABLE 1.—SURVIVAL OF PONDEROSA PINE SEEDLINGS BY FALL LIFTING DATES AND LENGTH OF COLD STORAGE

Date lifted	Storage period: None	1 month	2 month	3 month	Total[1]
	Number[2]				
Sept. 15	78	36	2	0	116
Oct. 1	80	44	23	0	147
Oct. 15	80	80	71	66	297
Nov. 1	80	80	76	76	312
Nov. 15	80	72	78	74	304
Dec. 1	80	80	80	74	314
Total [3]	478	392	330	290	1,490

[1]A difference between lifting date totals greater than 14 is significant at the 95 percent level of probability.
[2]Based on 80 seedlings per treatment.
[3]A difference between storage period totals greater than 18 is significant at the 95 percent level of probability.

TABLE 2.—SURVIVAL OF PONDEROSA PINE SEEDLINGS BY FALL LIFTING DATES AND SEED SOURCES

Date lifted	Seed zone: II	III	IV	V	Total[1]
	Number[2]				
Sept. 15	24	28	30	34	116
Oct. 1	28	35	44	40	147
Oct. 15	72	75	72	78	297
Nov. 1	78	76	79	79	312
Nov. 15	77	75	75	77	304
Dec. 1	80	78	76	80	314
Total[3]	359	367	376	388	1,490

[1]A difference between lifting date totals greater than 14 is significant at the 95 percent level of probability.
[2]Based on 80 seedlings per treatment.
[3]A difference between seed zone totals greater than 18 is significant at the 95 percent level of probability.

TABLE 3.—TOTAL NUMBER OF NEW ROOTS PRODUCED ON PONDEROSA PINE SEEDLINGS BY LIFTING DATES AND LENGTH OF COLD STORAGE

Date lifted	Storage period: None	1 month	2 month	3 month	Total[1]
	Number[2]				
Sept. 15	662	129	0	0	791
Oct. 1	1,197	236	142	0	1,575
Oct. 15	3,760	1,736	728	491	6,715
Nov. 1	3,190	3,016	758	1,287	8,251
Nov. 15	2,125	668	779	1,259	4,831
Dec. 1	3,746	1,571	1,315	1,756	8,388
Total[3]	14,680	7,356	3,722	4,793	30,551

[1]A difference between lifting date totals greater than 868 is significant at the 95 percent level of probability.
[2]Based on 80 seedlings per treatment.
[3]A difference between storage period totals greater than 1,064 is significant at the 95 percent level of probability.

TABLE 4.—TOTAL NUMBER OF NEW ROOTS PRODUCED ON PONDEROSA PINE SEEDLINGS BY LIFTING DATES AND SEED SOURCE

Date lifted	Seed source: II	III	IV	V	Total[1]
	Number[2]				
Sept. 15	150	242	167	232	791
Oct. 1	362	98	503	612	1,575
Oct. 15	1,198	1,983	1,900	1,634	6,715
Nov. 1	1,527	1,830	2,822	2,072	8,251
Nov. 15	934	954	1,773	1,170	4,831
Dec. 1	1,886	1,515	2,563	2,424	8,388
Total[3]	6,057	6,622	9,728	8,144	30,551

[1]A difference between lifting date totals greater than 868 is significant at the 95 percent level of probability.
[2]Based on 80 seedlings per treatment.
[3]A difference between seed zone totals greater than 1064 is significant at the 95 percent level of probability.

peared to increase the number although statistical significance could not be established (Fig. 2 and Table 3).

Lateral root elongation, like survival, was correlated with the seed collection zone. Except for Zones II and III seedlings, which behaved alike, seedlings from all zones differed significantly in the number of lateral roots that elongated following storage (Fig. 2 and Tables 4 and 5).

These data strongly suggest that the date seedlings were lifted for cold storage is responsible, in part at least, for the variable success experienced when Mt. Shasta and Oakdale stock were planted out in the field. Until recently, a large amount of the Mt. Shasta stock was lifted and placed in storage during early October, and Oakdale stock during February. Although the experimental data cover only the September to December period, they indicate that the deleterious effect of storage may be closely associated with a failure to achieve "physiological hardening" or "readiness" before being placed in storage. If this is true, some of the fall-stored Mt. Shasta stock, in contrast to the Oakdale stock, would have been in a poor physiological condition—perhaps even close to death—when delivered to the planting site the following spring.

These data may also explain the inconsistent behavior noted by earlier workers when comparing field survival of fall, spring, and freshly lifted stock. These workers treated fall-lifted stock as one class and failed to distinguish between stock lifted early in the fall and stock lifted late in the fall. On some occasions early fall and late fall lifted stock might even have been mixed up in storage since the bundles were not separated by lifting dates. Adding still further to the confusion was a failure to emphasize, in many of the early studies, the importance of seed collection zones.

Since the weather varies from one year to the next, there is a good chance that the physiological

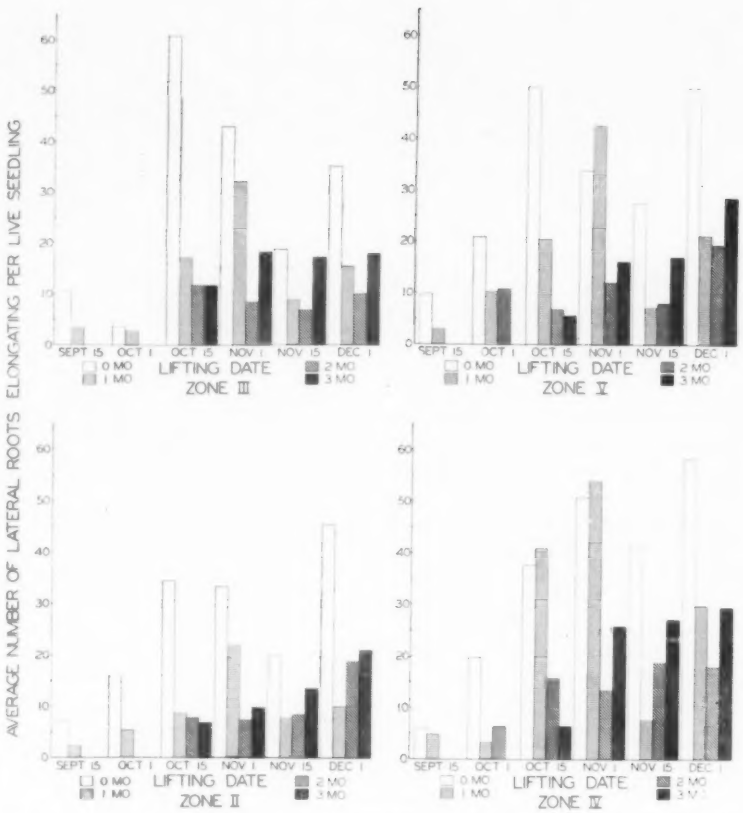

FIG. 2.—Lateral root elongation of 1-1 ponderosa pine seedlings after one month in the greenhouse following cold storage.

TABLE 5.—TOTAL NUMBER OF NEW ROOTS PRODUCED ON PONDEROSA PINE SEEDLINGS BY SEED SOURCE AND LENGTH OF STORAGE

Seed zone	Storage period				Total[1]
	None	1 month	2 month	3 month	
			Number[2]		
II	3,187	1,032	781	1,057	6,057
III	3,435	1,516	704	967	6,622
IV	4,233	2,811	1,257	1,427	9,728
V	3,825	1,997	980	1,342	8,144
Total[1]	14,680	7,356	3,722	4,793	30,551

[1]A difference between seed zone and storage period totals greater than 1064 is significant at the 95 percent level of probability.
[2]Based on 120 seedlings per treatment.

condition of the seedling at a specified date will not be the same each year. Although stock lifted on October 15 did not store well as measured by lateral root growth, while stock lifted on November 1 did, October 15 and November 1 are not necessarily critical dates. Perhaps in 1958 the weather will be such that stock lifted on October 15 will have already "physiologically hardened" and will store well. Similarly the seed collection zone might be correlated with survival and lateral root elongation one year but not the next. Certainly one would expect the critical dates to differ at each of the widely separated forest nurseries in the state.

Unfortunately the physiological condition of the seedling cannot be determined by inspection. Stock lifted on October 1 appears the

same after storage as stock lifted in November or December—the needles are as green and the roots as turgid and as firm. However, it should not be too difficult to develop some rapid method of measuring this physiological activity; perhaps gas exchange or reserve food measurements may provide the answer.

Although these data indicate that early fall lifting and storage may produce seedlings that are certain to die, they also indicate that stock lifted and stored later in the year has a good chance of survival.

Summary

1. Ponderosa pine seedlings lifted and placed in cold storage early in the fall did not survive when replanted under favorable conditions in the greenhouse. When lifted after November 1 almost all the seedlings survived.

2. Cold storage in general reduced the number of short lateral roots (stubs) that elongated during the first month after replanting in the greenhouse. The reduction was most pronounced when the seedlings were lifted and placed in cold storage before November 1.

3. Both survival and lateral root elongation of stock lifted and placed in cold storage before November 1 were correlated with the seed collection zone.

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Pennsylvania's Timber Resources Described

The forest land of Pennsylvania comprises 15 million acres and represents more than half of the Commonwealth's land area according to "The Timber Resources of Pennsylvania," a 46 page booklet reporting upon a survey made by the U. S. Forest Service Northeastern Forest Experiment Station in cooperation with the Pennsylvania Department of Forests and Waters.

Over the past several years, eight regional reports were published for the various geographical sections of Pennsylvania. Now, the statewide summary brings this sectional material together and adjusts most of it to a common date.

Pennsylvania's most heavily wooded counties, according to survey findings, are those in the Allegheny and North-Central sections, where forests cover 75 percent of the land.

The Commonwealth itself owns some 2½ million acres in state forests, parks, and game lands. The Allegheny National Forest, which is federally-owned, covers another 456,000 forested acres.

Most wooded lands, however, are privately owned—some 12 million acres. Larger tracts—5,000 acres or more—belong to coal companies, lumber and paper companies, oil firms, hunting clubs and the like. Yet, well over half of the private forest lands are in small tracts of less than 100 acres.

Farmers make up the largest single ownership class: they hold title to more than 3 million forest acres.

The timber resources report brings out many other facts about "Penn's Woods." For example:

One-fourth of the woodlands support sawtimber stands—containing 1,500 or more board feet per acre.

Hardwood types predominate, covering 95 percent of the commercial forest land. Commonest is red oak accounting for one-fifth of the hardwood volume. Other common hardwoods include chestnut oak, black cherry, sugar maple, white oak, red maple, beech, and yellow birch.

Hemlock is the most commonly cut softwood, comprising half of the softwood board-foot volume. Other important conifers are white pine, pitch pine, and Virginia pine.

Quality of Pennsylvania sawtimber is fairly good, better than average for the Northeast. But small trees make up the largest part of the timber volume.

The state's growing stock amounts to 12 billion cubic feet; the wood volume suitable for pulpwood totals 149 million cords.

Currently in Pennsylvania more timber is grown than is cut. But the biggest and best sawtimber trees are being cut faster than they are being replaced.

Copies of "The Timber Resources of Pennsylvania" are available from the Northeastern Forest Experiment Station, 102 Motors Avenue, Upper Darby, Pa.

The Influence of Soil Moisture on the Survival of Planted Douglas-Fir Seedlings on Clay Soils[1]

C. T. Youngberg

THE FOOTHILLS ADJACENT to the Willamette Valley in western Oregon present a diverse pattern of soils, vegetation, and land use. The soils are, in general, clays or clay loams developed on residuum and alluvial fan material from besalt, sandstones, and shales. Some of the better soils (Aiken series) support well stocked stands of Douglas-fir (*Pseudotsuga menziesii* [Mirb.] Franco), however, openings supporting grass or grass and Oregon white oak (*Quercus garryana* Hook.) also occur on Aiken soils and are very common on other fine textured soils. Land use consists of forest production and grazing with some hay production on the better soils and gentler slopes.

The increased emphasis placed on tree planting in connection with the Soil Bank program and the favorable Christmas tree market have stimulated the interest of some land owners in the afforestation possibilities on these lands.

In an earlier study, Youngberg (*9*) concluded that soil moisture was the most critical factor influencing the survival of planted seedlings in the non-forested openings in the Willamette Valley foothills. The narrow range of readily available water (between ⅓ and 1 atmosphere tension) in the clay soils and the early date at which soil moisture reached the "difficulty" available point (1 atmosphere tension) and the permanent wilting point (15 atmospheres tension) were considered to be the main causes of seedling mortality. The role of competing vegetation in moisture depletion was also suggested.

Richards and Wadleigh (*3*) have made a very thorough review of the role of soil moisture in plant growth and have pointed out that moisture is not equally available throughout the total range of availability, i.e., from field capacity to permanent wilting point. The investigations of Hagan et al. (*1*) have substantiated the earlier conclusions of Richards and Wadleigh and have done much to clarify the confusion that has existed in the thinking on soil-plant-water relationships.

The role of lesser vegetation in moisture depletion has been the subject of many studies. In some instances the influence on the survival of tree seedlings has been suggested. Lane and McComb (*2*) studied the depletion of soil moisture by grass and tree seedlings in the greenhouse. They concluded that the rapid rate of depletion of water by grass was the cause of poor seedling survival on sodded areas. Wilde and Albert (*8*), Stoeckeler and Limstrom (*5*) and Wakeley (*7*) have concluded that site preparation that improves moisture conditions either by minimizing competition or by providing for accumulation of soil moisture improves seedling survival. Shoulders (*4*) has demonstrated the importance of removal of sod in the survival of planted longleaf, slash, and loblolly pines in dry years.

The data reported in this paper are the results of a more detailed study of soil moisture depletion and seedling survival which was a follow up of the earlier study reported by the author (*9*).

Description of Areas

Two non-forested openings on McDonald Forest, the Oregon State College school forest, were used for this study. Both were at an elevation of 500 feet on west exposures. The soil on Area 1 was an Aiken silty clay loam (a Reddish Brown Latosol), which supported a rather dense cover of grass and bracken fern and an occasional oak and Douglas-fir. The soil on Area 2 has not been classified; however, it is similar to the Climax clay soil (a Grumosol) mapped in southern Oregon and will be referred to as such in this paper. It has a high percentage of the type of clays that swell and shrink with wetting and drying and cracks severely when dry. The vegetation is less vigorous than on the Aiken soil and consists mainly of various native grasses. For a more detailed description of the soils and summary of soil analysis data the reader is referred to the earlier paper by the author (*9*).

Experimental Procedures

This study extended over a three year period. Both areas were used the first year, but during the second and third years the study was confined to the Aiken soil area. On March 24 and 25, 1955 two plots of one hundred 2-0 Douglas-fir seedlings each were planted on each of the two soil types using a 2x2 foot spacing. Soil moisture was at field capacity at the time of planting and several inches of rainfall occurred during the first five days after planting. Beginning on May 12 and continuing until October 17, soil moisture samples were taken using a King tube, at the 0-6 inch, 6-12 inch, and 12-18 inch depths at weekly intervals. At the same time, seeding mortality counts were made.

On April 14, 1956, four plots of one hundred 2-0 Douglas-fir seedlings were planted on the Aiken soil using a 2x2 foot spacing. On two of the plots all competing vegetation was removed by scalping. Soil moisture conditions were again favorable during and after planting. Beginning on May 25 and con-

THE AUTHOR is forest soil scientist, Department of Soils, Oregon State College, Corvallis. He wishes to acknowledge the assistance given by Dr. G. H. Barnes, School of Forestry; Mr. C. T. Dyrness, research fellow in soils; and Mr. Dean Urie, research assistant in soils, Oregon State College.

[1]Technical Paper No. 1128. Oregon Agric. Expt. Sta., Corvallis, Ore.

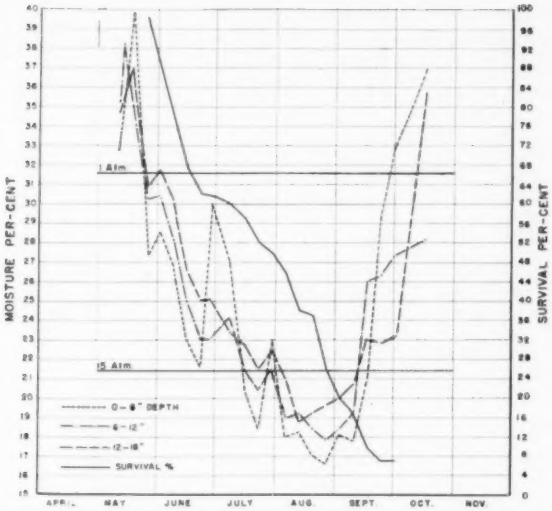

FIG. 1.—Soil moisture depletion and survival percentage for planted Douglas-fir seedlings on Aiken soil (1955).

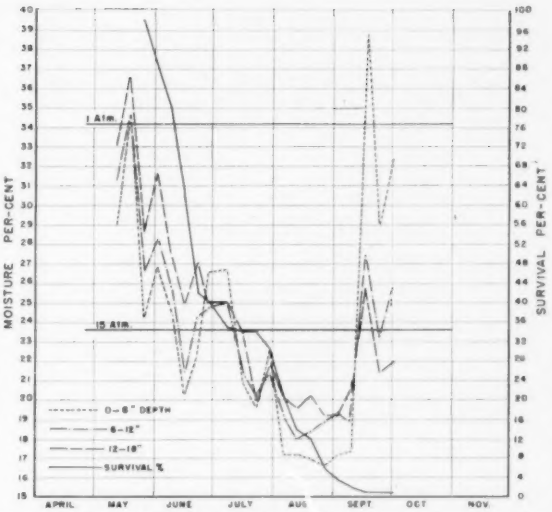

FIG. 2.—Soil moisture depletion and survival percentage for planted Douglas-fir seedlings on Climax soil (1955).

tinuing until October 5, soil moisture samples at the 0-6 inch, 6-12 inch, and 12-18 inch depths were taken and mortality counts made at weekly intervals. Examinations were made again on May 9, 1957, and finally on October 19, 1957, to evaluate second year mortality.

Results

The soil moisture depletion and seedling mortality data for 1955 from the Aiken and Climax soil areas are presented graphically in Figures 1 and 2. The data presented in these graphs are the averages for two plots on each soil type. Soil moisture depletion was rapid after May 20 with several short periods of deceleration of the depletion rate due to light rains. Seedling mortality increased rapidly as soil moisture was depleted. On the Aiken soil a replenishment of soil moisture in the 0-6 inch zone during the period of June 22-29 had a slight decelerating influence on the rate of seedling mortality. However, the rapid depletion of moisture during the first two weeks in July resulted in the 0-6 inch and 6-12 inch depths going below the 15 atmosphere percentage (permanent wilting point) by mid-July. The 12-18 inch depth reached this point during the first week in August. The total 18 inch depth remained below the 15 atmosphere percentage level until early September. After the slight deceleration of seedling mortality in early July, the rate of mortality again increased and continued until the early fall precipitation replenished the moisture supply. By this time, however, total mortality was 93 percent.

On the Climax soil the rate of seedling mortality also increased rapidly as soil moisture was depleted. The slight deceleration of the mortality rate evident on the Aiken soil during the period June 22-29 was not as evident on the Climax soil. This is perhaps due to the fact that on the Climax soil the moisture content in the 0-6 inch and 6-12 inch depths had reached the 15 atmosphere percentage prior to this period while on the Aiken soil it had not. There was a slight deceleration of the mortality rate during the middle of July, but as the moisture depletion progressed to the 15 atmosphere percentage point in all three depths the rate accelerated again resulting in a total mortality of 99 percent by the middle of September.

Cleared vs. uncleared plots.—The soil moisture depletion and seedling mortality data for uncleared and cleared plots in 1956 are presented graphically in Figures 3 and 4. The pattern of moisture depletion was similar under both conditions; however, it was more rapid on the uncleared plots than on the cleared. On the uncleared plots all three depths had reached the 15 atmosphere percentage by July 6 and remained below this point until September 12. On the cleared plots the 0-6 inch depth and 6-12 inch depth went below the 15 atmosphere percentage on July 8 and 10, respectively, but the 12-18 inch depth did not go below this level until August 28. On the uncleared plots the rate of seedling mortality increased sharply at the time when soil moisture went below the 15 atmosphere percentage level. After June 25 some mortality occurred every week on the uncleared plots resulting in a total mortality of 76 percent by October 5. On the cleared plots there was very little mortality until after August 10, with 13 percent occurring between this date and October 5 for a total of only 17 percent. Very little additional mortality occurred the second year on cleared or uncleared plots.

Discussion

The rapid rate of seedling mortality that occurred on both soils after the moisture tension went above the 1 atmosphere level (about May 20, 1955) appeared to support the earlier conclusion (*9*) that soil moisture tensions above 1 atmosphere tension had a definite influence on the survival of planted

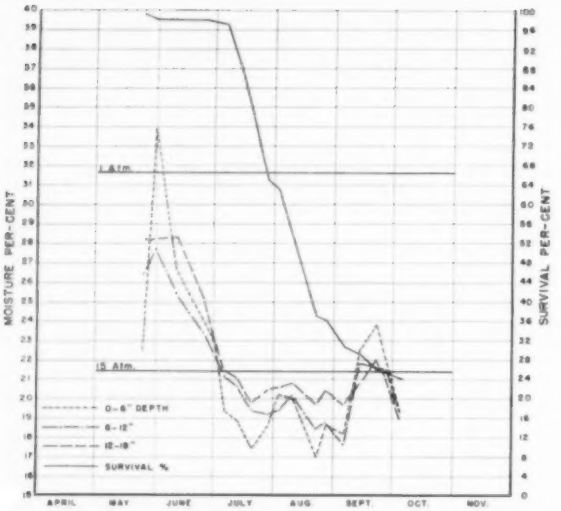

FIG. 3.—Soil moisture depletion and survival percentage for planted Douglas-fir seedlings on uncleared plots on Aiken soil (1956).

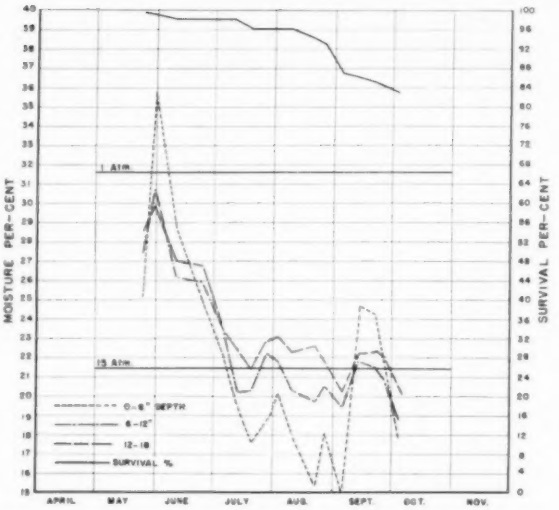

FIG. 4.—Soil moisture depletion and survival percentage for planted Douglas-fir seedlings on cleared plots on Aiken soil (1956).

seedlings. On the other hand, on the Aiken soil in 1956 the mortality rate did not show any marked increase until soil moisture tensions had reached 15 atmospheres. This apparent difference in the reaction of planted Douglas-fir seedlings to soil moisture stress may be due to environmental factors other than soil moisture or the result of physiological differences between the two lots of nursery stock used. Stone (*6*) has demonstrated the difference in the ability of coniferous nursery stock to regenerate new roots. This is an extremely important factor in determining the planted seedling's ability to compete for soil moisture.

Soil moisture depletion to the 15 atmosphere percentage point on the cleared plots in the 0-6 inch and 6-12 inch depths was five days slower than on the uncleared plots and in the 12-18 inch depth it was seven and one-half weeks behind this depth on the uncleared plot. The five day difference in the 0-12 inch depth would appear to be small and of no significance. It is impossible to measure moisture tension in the immediate root zone by taking soil samples with a tube. However, it is probably safe to assume that these small differences in the depletion rate reflect greater differences in soil moisture stress in the area immediately surrounding the seedling roots. It is also possible that the seedlings on the cleared plots were able to get their roots down into the 12-18 inch depth where moisture was available for a longer period of time. It has also been demonstrated that some of the native grasses in western Oregon inhibit the development of the roots of Douglas-fir seedlings.[2]

The extremely poor survival (7 percent) on the Aiken soil in 1955 and the unsatisfactory survival (24 percent) on the uncleared plots on Aiken soil compared with 83 percent survival on the cleared plots indicates without any doubt the necessity of site preparation to eliminate the competing vegetation. The complete failure on the Climax soil is a result of moisture competition and poor physical condition of the soil. Even with site preparation the severe cracking when the soil dries out is a definite hazard from the standpoint of the survival of Douglas-fir seedlings. Notable success has been obtained with planting of lodgepole and ponderosa pine and Douglas-fir from dry site seed sources on these Grumosol soils (*9*).

The results of this study indicate that site preparation to eliminate vegetative competition on soils in the lower foothills of the Willamette Valley is necessary to assure any success to planting operations. It is doubtful whether it is advisable to attempt planting on Grumosols. If an attempt is made, only drought-resistant species or strains should be used.

[2]Unpublished annual report Project 160-7, Oregon Agric. Expt. Sta., 1957.

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The Hatchet and Oilcan Technique for the Application of Sodium Arsenite

David B. Cook

THE USE of sodium arsenite to chemi-peel or simply to kill trees is by now a thoroughly-tested and well-established practice whose merits, limitations and hazards are widely understood. Since Cope and Spaeth (*5*) first introduced it into American silviculture in 1931, there have been many changes in methods of application and in tools with which to do the work. Because arsenite is toxic, it poses a hazard to both forest workers and wildlife (*1*), but these dangers have been grossly exaggerated. Dead and dying trees can be foci for outbreaks of harmful insects. But sodium arsenite is so effective and so economical that we are justified in making real efforts to overcome its difficulties and to learn to take with a smile the unpredictable but minor losses that may accompany its use.

The Hatchet and Oilcan Technique is no startling innovation; it is simply the end product of many years of testing chemical formulations, tools and procedures to find which combination would yield the best results with the least hazard and at the lowest cost. It was originally developed at Cooxrox Forest in response to our pressing need to accomplish more silviculture with less effort and fewer dollars, a situation that prevails widely among forest owners in the Northeast. The technique has been thoroughly tested by many foresters on a wide range of species and over a number of seasons. New York's purchase of some two thousand gallons of sodium arsenite solution for use on state forests in 1958, to be applied largely by this technique, affords some measure of its current use. I make no claim that the technique is without fault but, if properly used, it will achieve prompt and excellent results with a minimum of risk, at vastly less cost than older systems of thinning.

In the Northeast, this technique is applicable to both conifers and hardwoods and to trees from 1 inch d.b.h.—the minimum that will stand up to a hatchet stroke—up to such size that the bark is too thick to be chopped through with a single blow. Large-crowned, wolfy hardwoods require heavy dosages to achieve chemi-peeling; if this be required, such trees might better be treated by the standard procedure of sap-peeling a girdle and painting it with arsenite solution (*2, 3*). When only quick death is required, H & O can be successfully used on trees up to at least 24 inch d.b.h.

Tools

As indicated by the name, the tools used are a hatchet for making the cuts and an oilcan for applying the chemical. The familiar Boy Scout hatchet, weighing 1¼ pounds and with a 13 inch wooden handle, has been found entirely satisfactory for most work. Where a high proportion of thick-barked trees is to be treated, a heavier head will be advantageous but a one-hand tool is always indicated. As the object of the cut is to open an incision to be filled with chemical, the hatchet's edge should be kept sharp but thick.

The oilcan is an Hydraulic Pump Oiler made by the Eagle Manufacturing Company of Wellsburg, W. Va. It is all metal, positive and leak-proof in operation and practically indestructible. The one-quart size has a working capacity of one-fifth gallon or 26 fluid ounces. It weighs 1¼ pounds empty and not more than 3½ pounds when full; not uncomfortably heavy to carry in one hand.

Care must be exercised to prevent getting arsenite in the eyes or on unprotected skin. Ordinary glasses are adequate protection against spatter, for those who do not wear glasses, goggles of some sort are a "must." The plastic face shields used by welders serve admirably and can be worn over glasses.

The best skin protection that I have found yet is Kerodex No. 71 (Water Repellent) made by the Averst Laboratories of 22 East 40th Street, New York City. This greaseless cream is proof against arsenite, does not interfere with one's grip on tools and needs be applied only twice a day. It is cheaper and incomparably better than any form of glove, rubber or otherwise.

The Scout hatchet, the Eagle oiler and the face shield can be bought from bigger hardware stores or from mail order houses for $3.50, $2.40, and $2.00 respectively. Kerodex can be obtained from retail drug stores at $1.50 per tube, or in dozen lots direct from the manufacturer.

Over the past twenty-five years, I have experimented with sodium arsenite in many forms. The hatchet and oilcan technique was developed while I was using Chipman Chemical Company's Atlas "D" Debarking Compound, a formulation containing 3.77 pounds of arsenic trioxide in the form of sodium arsenite, per gallon, plus a dye and a wildlife repellent. But because H & O reduces the hazard to wildlife almost to zero, the repellent was deemed unnecessary and, in 1958, I began using Atlas "A-6," a 6-pound solution plus color. This formulation permits the injection of 1½ times as much active chemical with no change in procedure, no added effort.

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Arsenite solutions are heavy and therefore difficult to transport. The 5-gallon steel drum or even the 2-gallon one is too heavy to be readily carried around in the woods and pouring from such a container directly into an Eagle oiler entails great risk of spillage. For field transportation, I put the arsenite into the screw-cap metal cans in which detergents are sold. They hold 22 fluid ounces, can be completely emptied into the oiler without risk of overflow. As these weigh only 4 ounces, when empty, they can be carried out of the woods almost as easily as they can be thrown away. They are quickly sealed and unsealed and will withstand rough and repeated use. The contents of two such cans will last a careful worker at least a day; four can be handily carried in a carton. It is essential that these cans be conspicuously labeled as to their contents and under no circumstance should arsenite be carried in a container even remotely resembling a water canteen. Workers should be carefully instructed in the safe use of this chemical. At the end of the day, any arsenite left in the oiler can be easily and safely poured back into a can.

After work, the oiler should be taken apart, thoroughly washed in hot water and the working parts coated with light machine oil before reassembling.

The Operation

Every man who is to have any contact with arsenite should protect his hands and forearms with Kerodex as a first order of business. If the area to be worked has underbrush or ferns on which arsenite might possibly drip, it will be wise for the workers to apply Kerodex to the fronts of their legs, from mid-thigh down over the knee. This will prevent any drip that gets on foliage and then wipes off on pant-legs from getting through into bramble scratches and other minor abrasions. As the individual worker both makes the incisions and applies the chemical, there is *no chance of missing a tree.* Each man can set his own pace, so that the crew speed is *not necessarily* governed by that of its slowest member. If, after filling the oiler at the start, someone will carry one extra can of arsenite per worker, the crew can be free from its supply base for half a day. With reasonable economy, 14 pounds of arsenite solution per worker is a day's requirement, which each man can carry into the woods for himself.

Where they present a problem, as in softwood plantations, interfering limbs can easily be knocked off with the hatchet, which is a considerable advantage. A series of hacks is then made, deep enough to cut through the bark and to lightly score the sapwood. If chemi-peeling is desired, or if the tree has a big top and requires a heavy dose, *a complete frill is essential;* otherwise, the hacks may be 2 inches apart. Translocation of the chemical downward, even in late summer, seldom exceeds a foot. If the timber is to be salvaged for peeled wood or if sprouting is to be discouraged, the frill should be made at stump height; if only death is required it may be made where it is handiest. On small trees one or two hacks will be enough to kill them, but an incomplete girdle on any tree bigger than 4 inches d.b.h. is an invitation to trouble from lingering death and the possibility of inducing a build-up of insects.

The hatchet cuts are immediately filled *just full* of arsenite by placing the tip of the oiler at one end and gently applying just enough thumb pressure to force the liquid through to the other end. This requires some practice and considerable finesse but any chemical that dribbles out onto the bark not only is wasted but also poses a hazard to workers and a threat to wildlife. The Eagle oiler is so constructed that it will not drip; no arsenite should get on hands, clothing or foliage. On hardwoods, where a strong dose is required, Atlas "6-C" is best; on softwoods, the 4-pound solution will be adequate. Careful filling of the hacks will mean utmost economy of the chemical.

Timing

Hatchet and oilcan treatment should not begin until the spring flow of sap has ceased. If done in late winter or early spring, sap oozing from the cuts will wash out the arsenite, making a frothy mass that may be attractive to animals —with dire results. Once the hardwood leaves are fully expanded, all trees will be growing actively enough to quickly draw the chemical up from the point of application. Work can continue until the hardwood leaves begin to turn color, or perhaps a little later on conifers. For greatest efficiency and comfort, this is a summer job, best done between June 1 and September 15 and not during heavy rain.

Because of the great diversity of our timber and terrain, the wide variation in number and size of trees to be treated per acre, and the unpredictable ratio of working time to walking time, statements about cost per acre are of limited applicability. Working alone in my own plantations, selecting and treating 250 to 300 trees per acre, takes half a man-day and a scant half gallon of Atlas "D." Spruce takes longer than pine, whereas hardwoods can be thinned at a considerably faster rate. Large scale operations on state forests closely parallel these figures.

Results

Sodium arsenite injected into shallow hacks during the growing season is promptly drawn up through the cambium and the outer few layers of lignified cells, killing the issue as it goes (*6*). Within two weeks, conifer needles will redden and hardwood leaves will color and begin to droop. The dead bark soon dries out enough so that it is unsuited for the survival of most insect larvae. Hardwood leaves will fall prematurely; conifers will usually drop the dead needles in March. After a winter of freezing and thawing, the bark separates from the wood on all but the thinnest-barked stems and begins to crack lengthwise; on maple it may fall off entirely. By the next summer there will be only dead, dry snags, silviculturally inert. If sal-

vaged, the wood will be clean and light; if left, the trees will deteriorate slowly from the top down, leaving a naked pole too light to fall of its own weight.

Hazards

Sodium arsenite is toxic if taken internally and irritating to some people's skin but this should not be a cause for undue apprehension or panic. Kerodex will fully protect the skin against accidental contact but, if the H & O Technique is carefully followed, there should be none such. The danger to wildlife is nil. Conifers treated before September 1 may be attacked by bark beetles, borers and weevils. *Ips pini, Monochamus sp, Orthotomicus caelatus, Dryocoetes sp* and *Pissodes approximatus* are typical in New York. We have seen many and heavy attacks by *Ips pini* but no case where a brood has successfully been raised in the arsenited parts. Sawyer larvae will sometimes survive and complete their life cycle in white pine and red pine. The other species attack only dying and dead trees and pose no added risk to residual stands on good sites. Spring-treated hardwoods may become infested with ambrosia beetles, notably *Monarthrum mali* in oak.

Another hazard from the use of arsenite is backflash, by which the chemical passes from a treated tree to an untreated one— usually a vigorous dominant—through a root graft (*4*). This seems to be worst in red pine growing on windy sites, but the unpredictable loss of a few trees here and there is a small price to pay for the tremendous savings that can be made.

Summary

The Hatchet and Oilcan Technique provides a safe, quick, simple, sure and cheap way to eliminate unwanted trees, both hardwood and softwood. It requires a minimum of tools, no special equipment and no special skill. There is nothing to break, burst or get out of order. Anyone who can skillfully and vigorously handle a hatchet and is able to walk through the woods can do it. The risk to workers and to wildlife is reduced to the absolute minimum. The results are readily visible within two weeks. There will be no build-up of harmful insects or fungi. The cost is so low, in both chemicals and labor, that the use of this technique can extend our silvicultural dollar at least fivefold. Considering the immensity of the thinning task confronting us foresters, this is an approach to the reduction of stand density that merits most careful consideration and widespread use.

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Notes and Observations

Viability of Loblolly Pine Seed Stored in the Forest Floor

How long does loblolly pine seed remain viable in the forest floor?

This question arose in connection with a study of prescribed burning under a mature stand of loblolly pine (*Pinus taeda*) in the Pocomoke State Forest in Maryland. After burns made on April 3, 1956, 1,683 new pine seedlings per acre were tallied in the burned plots in late July. Did these seedlings start from seed that fell after the fire? Or did they start from seed that was stored in the unburned part of the forest floor?

Where Did Seed Come From?

From available information on loblolly pine seed dispersal, it seems highly improbable that enough seed fell after April 3 to have produced these seedlings. In an earlier study in a similar stand in the Pocomoke Forest (*4*), 94 percent of the catch of sound seed fell before January 15, and so little was caught between then and April 2 that observations were discontinued. Similar results have been obtained in other studies of loblolly seed dispersal (*2, 3*).

The other possible source would be seed already in the forest floor. Though the 1956 fires developed flames about 3 feet high, and were intense enough to kill a large proportion of the understory hardwood stems, they did not consume all the F and H layers of the forest floor. Seed in this unburned portion of the forest floor could have been the source for this reproduction.

Such seed might have come from the 1955 crop or from an earlier one. If they came from the 1955 crop, the seeds obviously had moved down a considerable distance into the forest floor to have escaped the fire. Nothing was known as to how far loblolly seed could reasonably be expected to penetrate the forest floor during one winter.

There was some reason to suspect that the seedlings had originated wholly or in part from the 1954 seed crop: in nursery and seed-spot sowings of loblolly pine, a small proportion of the seed will sometimes lie dormant until the following year[1] (*5*); and although there were no data on the longevity of loblolly seed in the forest floor, it was known that some pitch pine seeds remain viable in the forest floor for at least 1 year.[2] Therefore, it seemed quite possible that, on the plots, some loblolly seed of the 1954 crop could still have been viable and could have produced seedlings after the April 1956 burn.

The question of how long seed remains viable in the forest floor has been a controversial subject of special interest to North American foresters. Baldwin (*1*) reviewed the pertinent literature, which indicated that the seeds of many species soon lose their viability, while those of some other species have a longer retention of life, in a few species for several to many years. However, he did not mention loblolly pine.

A Study of Viability

In 1957, a small study was started to determine how long loblolly pine seeds remain viable in the forest floor. On March 4, in an unburned plot of the prescribed-burning study in the Pocomoke Forest, about 100 sound seeds from the 1956 crop were placed at each of 50 selected spots. At each spot the litter was carefully removed from a 1-foot square, and the seed was scattered on the center 6-inch square. Fifty spots were sown to provide five samples annually for 10 years if necessary.

A piece of window screening, 16 inches square, with 2 inches on each side bent down at right angles, was used to cover each spot. The bent-down edges of the screen were pushed into the forest floor after slits were cut for them. Wire pins were used at the corners to hold the screens firmly in place. A piece of plywood, 1 foot square with the center 6-inch square cut out, facilitated accurate placement of seed (and later collecting of samples for germination tests). After each screen was installed, the litter was carefully replaced.

The complete forest floor from the center 6-inch squares was collected from five spots on April 30, 1957, from five more on May 8, 1958, and from five more on July 14, 1958. At Center headquarters the individual samples were spread out under conditions suitable for seed germination.

Including a few seeds that germinated before collection, an average of 67 seedlings (per 100-seed lot) started in the 1957 samples. During the summer of 1957 five seedlings started in the remaining screened spots. In one of the spots sampled in 1958, four seedlings started before the May collection, but none at any of the other spots. No seedlings started from any of the samples collected in 1958.

In July 1958, seeds at uncollected spots were examined, and about 100 were cut. None were sound. Seed coats were then very soft. Apparently they had been greatly affected by the prevailing moisture

[1] Korstian, C. F., in correspondence.

[2] Little, S. Silvical characteristics of pitch pine. Manuscript in preparation for publication by U. S. Forest Service, Northeast. Forest Expt. Sta. 1959.

and fungi of the forest floor, in which hyphae were conspicuous. (On drier sites seed coats may decay less rapidly.)

The four seedlings that started in 1958—the second spring after the seeds were produced—represented only 0.1 percent of the seeds still experimentally stored in the forest floor. In view of that result, probably only a few, if any, of the pine seedlings that started after the 1956 fire came from the 1954 seed crop. The most logical inference is that they came from seeds of the 1955 crop that had penetrated deep enough into the forest floor to escape the fire.

Regardless of the source of those seedlings, it is evident from the results of this study that, at least on sites similar to the study area, very few seeds of loblolly pine remain viable in the forest floor through the second winter after they mature.

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Notes on Cruising Intensity by the Bitterlich Method

In his article[1] appearing in the May, 1958 issue of the JOURNAL, M. Afanasiev states: "Since Bitterlich Method of cruising *cannot be described in terms of a single percent of intensity* (italics mine), the decision on the number of points and their spacing in the field should be based on the desired intensity of a specific d.b.h. class. The cruiser might choose either the average diameter, or the one containing as a class the largest volume, or any other diameter of special significance in the ultimate objective of the cruise."

In what follows I will undertake to prove that the intensity of the cruise by the Bitterlich Method is a function of: (1) number of sample points randomly chosen; (2) average basal area per tree; (3) cruising area dimensions.

However, when some diameter classes are of special interest, then the average basal area of these trees instead of all trees will be the factor affecting the intensity of the cruise.

Consider now that the critical angle of 104.18′ is used.

Let A denote the total cruising area in square feet, B denote the total basal area of all trees on the cruising surface in square feet, r denote the radius in inches of the tree and N denote total number of trees in cruising area.

$$\text{Then } B = \sum_{i=1}^{N} \frac{\pi r_i^2}{144}$$

Consider now a circle around each tree with radius $R = 66\ r$ and surface equal to $\frac{\pi R^2}{144}$. These circles will overlap and therefore each point of the cruising area is covered by one or more such circles, sometimes by none.

$$\text{Let } C = \sum_{i=1}^{N} \frac{\pi R_i^2}{144} = \sum_{i=1}^{N} \frac{66^2 \pi r_i^2}{144} = 4356\ B$$

$$\text{Then if } m = \frac{C}{A} = 4356\ \frac{B}{A}$$

A point sample of the cruising area will be covered in average by m circles.

$$\text{Also if } A' = \frac{A}{66 \times 660} \text{ (i.e. cruising area is expressed in acres) then } m = \frac{4356\ B}{43560\ A'} \text{ or}$$

Basal area per acre $= 10\ m$.

Consider now that a random sample of n points has been taken, and let K_j be the number of trees counted in j-th point.

Because the sample is random then K_j is a random variable, and, under the assumption of normality of population and homogeneity of variance, standard statistical methods can be applied to estimate the mean and standard deviation.

Consider now the fraction of surface C covered by our sample where each sample point covers a surface equal to the sum of the circles surfaces of all trees counted at the same point. Denote the surface covered by our sample by c.

Then the expected value of c will be equal to

$$Exp(c) = Exp\left(\frac{C}{N} \sum_{j=1}^{n} K_j\right) =$$

$$Exp\left(\frac{C}{N}\, n\, \overline{K}\right)$$

$$= \frac{C}{N}\, n\, Exp\,(\overline{K}) = \frac{Cnm}{N}$$

$$\text{where } \overline{K} = \frac{1}{n} \sum_{j=1}^{n} K_j$$

Then the expected percent cruise $p = \frac{100c}{C}$ will be estimated at

[1] Afanasiev, M. Some results of the use of the Bitterlich method of cruising in an even-aged stand of longleaf pine. Jour. Forestry 56:341-343. 1958.

$$Exp\,(p) = \frac{Exp\,(c)}{C} \times 100 = 100\frac{nm}{N}$$

and if we replace m by $\frac{C}{A} = 4356\frac{B}{A}$

then $$Exp\ (p) = \frac{100n}{N} 4356\ \frac{B}{A}$$

$$= \frac{100\,nB}{10\,NA'} = \frac{10n}{A'}$$

$$\times \frac{B}{N} = \frac{10n}{A'}\text{b}$$

where $b = \frac{B}{N}$ = average basal area per tree.

Therefore, under the definitions considered, the intensity of the cruise is dependent on

(1) number of sample points,

(2) average basal area per tree,

(3) cruising suface,

and consequently the distribution of the trees by diameter classes is affecting the intensity of the cruise only by its measure of concentration (mean) and not by its measure of dispersion (variance).

But if the intensity of the cruise *can be expressed in a single number* we cannot say anything about the way of calculating it. Bitterlich's method does not provide a way of determining the average basal area and this has been recognized by many writers on this subject. Some of them, as L. R. Grosenbaugh in "Better Diagnosis and Prescription in Southern Forest Management" (Occasional paper 145) suggest measuring the diameter of each sampled tree. Since the probability of sampling a tree is directly proportional to the square of its diameter then the population of the sampled trees should be corrected first by having the basal area, volume, etc., weighted inversely to the probability of each tree being sampled.

However this largely destroys the great advantage of Bitterlich's method which eliminates the measurements of plot area and tree diameter. A substitute for Grosenbaugh's suggestion is necessary.

One method would be to establish a circular plot of 8.32 feet radius, concentric with the sample point. Count all trees inside this plot and thus estimate the number of trees per acre since the area of the circle is $\frac{1}{200}$ acres. The average basal area per acre, as determined by sample points, divided by the average number of trees per acre will give the average basal area per tree. The size of the plot should be primarily a function of the accuracy wanted and the density of the stand.

A second and much more accurate method would be to measure exactly the diameter of each tree found in the plot considered above. These trees would then represent a random sample of trees, since the sample of Bitterlich points is random. Consequently these sample trees will allow us to estimate the tree distribution in the cruising area considered.

Let us take a hypothetical case and have

1. the sample size n = 100;

2. average basal area per tree = .267 square feet corresponding to a 7 inch diameter tree;

3. the standard deviation of the basal areas of the trees is approximately 100 percent of the average basal area per tree (as calculated from 3 actual softwood, mixed wood and hard wood stands with close value of average basal area per tree).

Then the standard deviation of the mean $= \frac{.267}{10} = .0267$ and mean $\pm$ 2 standard error = .267 $\pm$ .053.

i.e. in 19 cases out of 20 the average basal area per tree will be estimated within 20 percent of the true mean (or within .5 inch diameter class).

Should a closer estimate be necessary the radius of the plot or the number of Bitterlich points can be increased. Note that one tree (or a constant number of trees) per sample point will not provide a random sample of trees unless trees are uniformly spaced. It is generally known that, all conditions identical, open stands will have larger trees since growth of tree is function of light received.

A random sample of points being a random sample of area implies that smaller trees have a smaller probability of being selected.

Note also that the sampled trees can also be described with respect to their species, height, percent of cull or any other pertinent characteristics.

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International Tree Disease Study Launched

An international projeet directed toward the discovery and evaluation of important foreign tree diseases before they move from one country to another has been launched through the cooperative efforts of the University of Wisconsin, The Wisconsin Conservation Department, the U. S. Forest Service, and the International Union of Forest Research Organizations.

Dr. A. J. Riker, professor of plant pathology of the University of Wisconsin, began in September a 5-month, 18-country tour in which he is interviewing forest pathologists as a first step toward achieving understanding for a larger, longtime project. His immediate objectives are: (1) To discuss with leading forest pathologists in important selected countries the problems of invasions by important tree diseases. (2) To work out a feasible plan for testing certain important foreign species and varieties in suitable countries to see whether critical but uncatalogued diseases may be present. (3) To help initiate a study to determine whether certain foreign trees are equal to or superior to local trees in various characteristics, including disease resistance. (4) To provide an improved basis for protec-

tion of forest trees against foreign diseases. (5) In other ways to advance the plans of the Working Group on International Cooperation in Forest Disease Research of Section 24, International Union of Forest Research Organizations. (I.U.F.R.O.)

Reasons for undertaking the work.—In the past certain foreign diseases have caused catastrophic losses. Examples for the United States are chestnut blight, white pine blister rust, and Dutch elm disease.

Many important diseases are known and doubtless others are still unknown that are potentially dangerous.

Nowadays when men and freight of all kinds move by air from place to place so rapidly the danger has been greatly increased. Even the best quarantine services are inadequate safeguards. More information is needed about the occurrence of diseases on all continents, about their potential threat to forest trees on other continents, about improved methods of delaying or preventing their spread, and about control measures to use if and when a disease should be introduced from abroad.

Each country might consider this study as a means for (1) detecting foreign diseases important for its native trees, (2) learning about possible disease resistance of related species, and (3) finding valuable foreign trees.

Procedure.—This present plan is the first step toward achieving understanding for a larger longtime project. The larger project is outlined:

A pattern of operation will be developed from that now so successfully employed in the study of wheat diseases. Following gradual development, now over 50 wheat nurseries are being studied in various places. The U. S. Department of Agriculture has been instrumental in carrying out the program.

Initially only trees growing in temperate zone forests will be considered. Early work may be limited to pine and poplar trees, until expansion should be indicated.

The following steps are among those contemplated: (1) Seed from elite trees of important species would be collected and made available. (2) Such seed would be grown in suitable locations where it was desired. (3) Competent pathologists would observe how well the trees grew and would examine any failures to determine whether dangerous diseases were responsible. (4) Successful trees would be available for future work. They would be observed for possible disease resistance and for other desirable characteristics. (5) Any dangerous diseases found would receive appropriate attention. (6) Information secured will be supplied to others interested in the program.

Seed collection and treatment to destroy seed-borne diseases, seedling production, and subsequent care and study of plantations would be arranged with suitable men in each cooperative country.

One of the chief problems for such a program will be to avoid misunderstanding between men in different countries concerning the difficulties and the enormous benefits that may develop.

In addition to the Institutional units involved, cooperation would be enlisted from all members of the Working Group in International Cooperation in Forest Disease Research of Section 24, I.U.F.R.O., and from forest pathologists and entomologists in the countries visited.

Low-Volatile 2, 4, 5-T Effective As Basal Spray

A low-volatile ester of 2, 4, 5-T was just as good as a more dangerous high-volatile ester in killing sweetgum (*Liquidambar styraciflua*) in east Texas. The low-volatile ester was 2, 4, 5-T (propylene glycol butyl ether ester) while the high-volatile ester was 2, 4, 5-T (pentyl or amyl ester).

The herbicides were applied on 240 small trees during May in two concentrations as a basal spray. The results in terms of percent of treated stems killed are presented in Table 1.

The low-volatile ester killed slightly more stems than the corresponding high-volatile mixture. As would be expected, the higher concentrations of chemicals killed more stems than did the lower concentrations. In neither case were the differences statistically significant.

TABLE 1.—STEM KILL BY VARYING TREATMENTS

Basal spray solution	Proportion apparently dead	
	After one growing season	After two growing seasons
	Percent	*Percent*
4 lbs. low-volatile 2,4,5-T acid per 20 gals. diesel oil	75.0	96.7
4 lbs. high-volatile 2,4,5-T acid per 20 gals. diesel oil	56.7	90.0
2 lbs. low-volatile 2,4,5-T acid per 20 gals. diesel oil	45.0	86.7
2 lbs. high-volatile 2,4,5-T acid per 20 gals. diesel oil	51.7	83.3

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The Effect of Understory Competition on the Growth Rate of Ponderosa Pine in North Central Oregon

Many foresters in the north central Oregon area are becoming increasingly concerned with the reduction in vigor and growth which has apparently been occurring in the pine overstory since the advent of forest fire control in this area.

This is a region of rather limited precipitation as compared to many other regions where ponderosa pine grows. Since available soil moisture is the limiting factor in growth in most ponderosa pine stands, the development of a dense understory of trees, brush and grass which has occurred over wide areas results in severe competition for the limited soil moisture of the typically arid pine sites. Such competition could be the reason for reduction in vigor and growth. Weaver has commented upon this situation (*1* thru *8*).

In July, 1938, a severe fire swept over approximately 20,000 acres of the Warm Springs Indian Reservation Forest. The fire was contained along a portion of its western edge by a bulldozed line across approximately two miles of generally level ground. Over the years, this line was gradually converted into a woods road.

This report concerns itself with our attempt to determine if the reduction in understory density in the burned area could be correlated with an increase in growth of residual trees. Twenty sample trees were tallied on each side of the road. It was assumed that such factors as soil, topography, elevation and precipitation are as nearly identical as possible. All trees tallied were open-grown individuals in Keen's Class 2B. It was felt that the younger, more rapidly developing trees would be more likely to reflect changes in growth rate.

Determination of associated understory vegetation and/or ground cover was made by a radii-point system. Forty points for determining ground cover at each sample tree were located as follows:

Eight radii, each 40 feet long and 45° apart, were located around each sample tree by use of a hand compass and a measuring tape. Five points were located at 8 foot intervals on a tape at each radius and any ground cover that was vertically above or below each point was tallied as either trees, brush, grass, (any herbaceous) or barren. A summary of the data collected appears in Table 1.

Two increment borings were taken of each sample tree and the average radial growth inside bark to the nearest 1/100 inch for the last three decades back from time of sampling was determined. The period from 1948 to 1957 is referred to as the first decade, 1938 to 1947 as the second decade, and 1928 to 1937 as the third decade. Thus, the first decade represents growth after the trees recovered from the shock of scorching and cambium damage.

TABLE 1.—SUMMARY OF VEGETATIVE COVER

Ground Cover Points	Burned	Unburned
Tree points		
Number	35	127
Percent	4.3	15.9
Brush Points		
Number	64	236
Percent	8	29.5
Grasses		
Number	199	92
Percent	24.9	11.5
Barren		
Number	502	345
Percent	62.8	43.1

Conclusions from Inspection and Analysis of Data

1. Reproduction and brush were lower in density on the burned than on the unburned area, while grass (herbaceous plants) was slightly greater on the burned area. Total vegetation cover was lower on burned than on unburned; or, conversely, the percentage of bare ground was higher on the burned area. This is obvious from the averages, but these differences are seen to be real and significant by inspection of the distribution of points tallied or by statistical analysis.

2. Diameter growth in the most recent (first) decade averaged much higher in the burned than in the unburned areas. Comparison of ratios of growth as shown in Table 2 indicates the growth of first decade to growth of third decade to be 187 percent *vs.* 118 percent. Analysis of individual tree ratios shows this difference to be highly significant.

3. A truer comparison is afforded by a covariance analysis of first and third decades diameter increments. This gives an adjustment of average rates based on regression. The average adjusted rates (corrected for difference before burning) are 0.68 inch for the burned area and 0.41 inch for the unburned area—a difference of 0.27 inch. This difference is statistically significant at the 5 percent probability level (radial growth inside bark). The trees in the burned area are therefore growing 66 percent faster than those in the unburned area in the most recent decade.

4. Since there is a significant difference in diameter growth and also in vegetation density between the burned and unburned areas, one might expect to find a definite correlation between growth rate in the first decade and vegetation density. A covariance analysis was made to test this relationship; using adjusted growth rates (as described in preceding paragraph) and number of bare spots as the two variables. The regressions proved non-significant, however, as there was too much variation from a consistent relationship among the individual trees. This is also evident from an inspection of the data arranged in order of magnitude, either of number bare spots or growth rates. This does

TABLE 2.—SUMMARY OF GROWTH BY DECADES

Growth (average)	Burned	Unburned
	Inches	
1st decade (1948-1957)	.70	.40
2nd decade (1938-1947)	.47	.35
3rd decade (1928-1937)	.39	.34
Adjusted 1st decade	.68	.41
Ratio of growth in 1st decade to growth in 3rd decade	187%	118%

not prove there is no such relation, but only indicates that there are so many other unmeasured or uncontrolled factors affecting growth that the possible relation is obscured.

5. A test of correlation of growth with trees-plus-brush density was considered, but inspection of the array together with the results obtained in the all-vegetation analysis indicated that would likewise be non-significant.

6. When it is considered that we are dealing with an average difference in total vegetation density of only 18.7 percent (56.9 percent on unburned *vs.* 37.2 percent on burned) the average difference in adjusted growth rates of 66 percent appears substantial.

7. The difference of 66 percent assumes greater significance when it is translated into board-foot growth. Assuming a gross growth rate of 80 board feet per acre per year in the unburned area, similar growing stock in the burned area would show a gross growth of 133 board feet per acre per year.

8. The second decade was ignored for the analysis of this study because we do not know the exact history of the measured trees, and it is possible that many of them had crowns scorched so severely, or cambium so damaged, as to delay for a time any increased growth due to the removal of competition. However, it is notable that there was appreciable gain in increment in the second decade over the third decade in the burned area.

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Potato Stick Seedlings

During the planting season of 1958-1959, the staff of the Waycross State Forest, Waycross, Ga. was faced with a vexing problem. Site preparation had been made to plant approximately 250 acres of a burned-over peninsula extending into the Okefenokee Swamp. Preparation consisted of broadcast harrowing modified by planting lanes. Only a few days before the scheduled planting, heavy rains made the area resemble a rice paddy. Mud not only clogged the planting machines; it pressed backward covering the seats. A conventional dibble hole closed up as soon as the dibble was removed.

At the suggestion of Edward Moore, a staff member, a planting stick similar to the farmer's potato stick was tested. This stick is about 4 feet long with a notch cut into the small end. The seedling is placed on the ground, the notch catches the end of the tap root, and the seedling is then gently shoved into the soft dirt. As with the dibble, tamping is done with the foot.

This method was used as a last desperate resort in planting the soggy area. Sample plots during the following growing season showed good height and vigor and a surprisingly high survival—80 percent or better.

The experience here is passed on to foresters having the same problem of planting low, wet areas. It is not recommended as a deliberately planned operation, but as an emergency method when more conventional methods of reforestation are not practicable.

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Points of View

Appraisal Objectives the Same—Results Differ

Although Wood and Ker's "Stumpage Appraisal on the U.B.C. Research Forest"[1] is interesting as a technique, it is even more interesting to me as an opportunity to compare their appraisal results with those obtained by another agency with the same objectives.

The U. S. Forest Service appraises timber to an operator of average efficiency[2] as do the U.B.C. timber appraisers. "National forest timber pricing policy and sale conditions must be attractive to private capital to obtain needed new plant facilities and to maintain those now existing," says the Forest Service Manual.[3] The U.B.C. appraisers "must give due consideration to the risks undertaken by the operator and assure him a fair return on his invested capital."

Stumpage price is recognized by the U. S. Forest Service as a residual value left after allowances for production costs and a margin for profit and risk have been subtracted from the selling value of the products manufactured from the timber.[4]

The quality of the appraisal results is not determined by the stumpage prices it yields but by the quality of the estimates of product prices, operating costs and margins for profit and risk used in arriving at stumpage rates. There have been some questions regarding the quality of the U. S. Forest Service's allowances for profit and risk as developed through the analysis of transactions evidence.

Presumably, the example used in the explanation of the B.C. appraisal system includes what the appraisers consider is typical of a "fair return." Table 1 expresses the margin for profit and risk directly in dollars for various selling-price classes of logs. The data in the table indicate that the example is not high in value or profit margin, and the 40 percent "profit factor" (margin divided by conversion return) is the lowest used by the B. C. Forest Service.

The U. S. Forest Service uses the "profit ratio" (the margin divided by the sum of operating cost and stumpage price) as the determinant of the profit allowance. Others have suggested that profit as a percent of sales is a good measure.[5] These devices are useful tools for a comparison of the margin allowed in different regions or different times. Since they are percentages, they remove difficulties resulting from differences in log rules and money values.

The calculation of these ratios from U.B.C. data gives these results for the example month:

Log grade	(1) Volume M bd. ft.	(2) Aver. selling price/M	(1)×(2)	(3) Costs, royalty and stumpage	(1)×(3)
1	107	$80.00	8,560.00	$57.60	6,163.20
2	305	61.50	18,757.50	47.60	14,518.00
3	85	42.50	3,612.50	34.60	2,941.00
	497		30,930.00		23,622.20

Weighted average log selling price $= \frac{30{,}930.00}{497} = \$62.23$

Weighted average logging costs, royalty and stumpage $= \frac{23{,}622.20}{497} = \$47.53$

Weighted average profit & risk margin $= 62.23 - 47.53 = \$14.70$

Margin expressed as percent of log selling price $= \frac{14.70}{62.23} = 23.6$ percent

Margin expressed as percent of logging, royalty and stumpage costs $= \frac{14.70}{47.53} = 30.9$ percent

For comparison purposes, here are the weighted-average profit ratios in the U. S. Forest Service offerings in the California Region from 1952 through 1958. These are computed from appraisal data and advertised prices for all non-salvage sales offered at $20,000 or more.

	1952	1953	1954	1955	1956	1957	1958
Volume of sales MMBM	358	439	936	1094	770	709	993
Number of sales	46	56	76	91	63	69	86
Margin expressed as percent of lumber price	14.5	10.8	9.9	10.5	11.3	10.4	9.9
Margin expressed as percent of logging, milling and stumpage costs	17.0	12.1	11.0	11.7	12.7	11.6	11.0

We should also note that the U.B.C. sales practice reduces risks due to monthly changes in the market. Marketing practices in California do not permit the reduction of risk to the same extent, so the allowance for risk should be greater in that state. However, the profit ratios developed through transactions analysis by the U. S. Forest Service in California (where half of the commercial timber is in national forests) are less than half as big as those used in British Columbia.

Recognizing that each approach may be less than perfect, there still is room to wonder at the difference.

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[1] Wood, R. S. and J. W. Ker. Stumpage appraisal on the U.B.C. research forest. Jour. Forestry 57:363-365. 1959.
[2] 1955 Review Draft, Chapter 5, Title 7 of the Forest Service Manual, Section 501.5.
[3] Op. cit., Section 501.4.
[4] Op. cit., Section 502.1.
[5] Weintraub, Sydney. An examination of some economic aspects of Forest Service stumpage prices and appraisal policies. U. S. Dept. Agric., 1958.

Book Reviews

Plant Propagation: Principles and Practices

By Hudson T. Hartmann and Dale E. Kester. 559 pp. Illus. Prentice-Hall, Inc., Englewood Cliffs, N. J. 1959. $8.75.

The authors have made a fine contribution to a field in which there is a dearth of good literature. The book covers most of the ornamental plants, fruits and nuts which are presently in cultivation. For $8.75 the purchaser can obtain a wealth of excellent material, presented in 559 pages of well presented text and approximately 200 photographs and drawings.

This book is written in a manner that offers clear understanding for the reader whether he is seeking the scientific theory and approach or if his primary interest is in the actual propagation techniques and operations only.

To orient the reader there is an introductory chapter and one devoted to soil mixtures, propagating structures, containers and media. Sexual propagation is covered in Part II. The opening chapter is concerned with the development of fruits and nuts and clearly explains the flower production and its maturation into a fully developed seed. A chapter is devoted to the principles of seed selection, another to the techniques of seed production and handling. The chapter on seed propagation (principles) is followed by a chapter on seed propagation (techniques) —this includes testing, pregermination, treatments, germination, disease control and seedlings production indoors and on the nursery.

In Part III the authors discuss vegetative propagation, asexual propagation, with an entire chapter devoted to the general aspects of the subject. The anatomical and physiological features of vegetative propagation are given good coverage, and then the next chapter presents the techniques of propagation by cuttings. Budding and grafting, layering and propagation by specialized stem and root cuttings complete this section of the book.

The last section, Part IV, covers the propagation of specific plants of economic importance. One chapter is concerned with fruit and nut crops, one with woody ornamentals, and one with annuals and perennials. A detailed index consisting of 13 pages and lists of supplementary readings add to the reference value of this useful and well written work.

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The Elk of Jackson Hole

By Chester C. Anderson. Bulletin No. 10, 184 pp. Illus. Wyoming Game and Fish Commission, Cheyenne. 1958. No price indicated.

Current and historical information on the Jackson Hole elk herd is reviewed in this bulletin. Data are presented on elk population dynamics; herd distribution, migration and feed ground habits; range conditions and hunter harvests.

Records reviewed by the author establish that large numbers of elk once migrated to desert winter ranges south of Jackson Hole. Land use changes and human exploitation led to the progressive elimination of the elk which habitually migrated to the desert. The portion of the elk herd which habitually wintered in Jackson Hole was permitted to increase beyond the carrying capacity of their winter range. An estimated 20,000 to 30,000 elk descended on the farm and ranchlands of the Jackson Hole Valley in the winter of 1909. The first large scale hay feeding program was initiated. Hundreds of elk starved. The problem redeveloped during the winter of 1911. Public interest and pressure prompted the acquisition of lands to raise hay for elk. A 25,000-acre National Elk Refuge was created.

Elk have been artificially fed on the National Refuge during all but seven winters since 1912. Additional feedgrounds are maintained outside the refuge. Artificial feeding has not relieved the use on native forage plants. Browse plants have been killed out in ever-widening zones away from feedgrounds. Excessive use of grass and soil followed. Moving feed grounds only extended severe overuse into new areas. Deteriorated forage conditions occur on spring ranges considerable distances from feedgrounds. An overall reduction in range carrying capacity has coincided with the elk feeding program. Numbers of elk in the Jackson Hole herd have progressively declined. Calf production and survival is low. At face value artificial feeding has maintained a herd of elk which have become adapted to feed ground conditions, but this has not been done without detrimental effects on the range and the elk themselves.

Management of the Jackson Hole elk herd is hindered by large land areas being closed to hunting. Only segments of the herd are readily available to hunters. Forage conditions are considered to have a greater influence on the elk herd than hunter harvests. Trends in range conditions are downward on all major wintering areas.

Perhaps the greatest value of this bulletin is in its example of the consequences of not managing an elk herd in relation to its range. Artificial feeding has apparently served only to intensify and pro-

long the problem. Those responsible for the situation, either by action or inaction, can hardly be proud.

Unfortunately, the bulletin leaves something to be desired in organization and style. In the reviewer's opinion, data are too limited to justify the 184 pages and a more severe editing job would have greatly facilitated reader comprehension. Some chapters are illogically separated and their subjects receive multiple treatment. A single chapter on Population Dynamics could well have sufficed for those on Population Trends, Herd Losses, Sex Ratios and Productivity which are chapters 4, 7, 12, and 13 respectively. Three chapters on elk migration and distribution habits could have been combined or at least treated in sequence. Presentation of tables, graphs, and diagrams does not follow any recognizable style. Perhaps the most serious shortcoming of the bulletin is the absence of a summary. A final listing of management recommendations would also have been desirable.

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Water Street, U.S.A.

By William H. Carr. 65 pp. Illus. Arizona-Sonora Desert Museum and the Charles Lathrop Pack Forestry Foundation, Tucson, Ariz. 1959. No price indicated.

A well illustrated publication, this booklet describes the establishment and content of a unique, permanent educational exposition devoted to the water cycle and the natural processes centering around water. The exposition is located at the Arizona-Sonora Desert Museum about 15 miles west of Tucson, Arizona.

In addition to *Water Street, U.S.A.*, the Desert Museum contains an extraordinarily interesting collection of living plants and animals characteristic of the Sonoran Desert. It is located in one of the finest of saguaro forests in a beautiful desert and mountain landscape. The museum is a conservation agency devoted to education about and appreciation of life in the desert and the water which regulates it.

The conception, design and development of the Water Street is the work of William H. Carr, assistant to the president of the Charles Lathrop Pack Forestry Foundation. The idea came from visits to the Sierra Ancha and San Dimas Experimental Forests of the U. S. Forest Service. It was Mr. Carr's purpose, and one in which he has succeeded very well, to bring to the general public the story of water and watersheds and the work of scientists concerned with watershed problems.

One of many unique features of the exposition is the use of electronic and mechanical equipment in explaining and demonstrating the water cycle. At each stop on "Water Street" a label describes briefly what is shown. Near the label are two push buttons. The top button activates a tape-recorded message explaining in more detail the principle or process involved. The lower button connects the visitor with a staff member in a centrally located tower to whom questions can be addressed and answers received. Many of the electrical and mechanical devices are the work of Mr. Everett L. Hamilton, recently retired after many years with the Forest Service at San Dimas.

At the first stop on "Water Street" a tape-recorded message introduces the general subject. Subsequent stops show and explain soil profiles formed under different rainfalls, the collection and measurement of precipitation, telemetering devices for transmitting rainfall data, the action of raindrops on soil protected and unprotected by vegetation, infiltration of water into soil and evaporation from open-pan evaporimeters. Other exhibits are devoted to capillarity, transpiration, solar radiation, wind. Several lysimeters illustrate surface run-off and deep seepage, and planted plots deal with climate and vegetation and the management of desert grasslands. In addition there are ecological walk-in cage enclosures with living plants and birds characteristic of the Arizona-Sonoran Desert and a portion of Mexico. The last two stops on "Water Street" are a summation room where a two minute slide show deals with "Rain in the Desert" and a building housing the U. S. Forest Service show "Water from Mountain to Desert."

It is well worth the time of visitors to Arizona to drive west from Tucson to the Desert Museum and study first-hand this most interesting exposition.

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1001 Questions Answered About Trees

By Rutherford Platt. 381 pp. Illus. Dodd, Mead & Company, New York. 1959. $6.

In his delightful poem, "How John Quit the Farm," James Whitcomb Riley wrote:

He'd ask more plaguy questions
In a mortal-minute here
Than his grandpap in Paradise
Could answer in a year!

And if some of the "plaguy" questions pertained to trees, as no doubt they did, I'm sure that grandpap would have welcomed having a copy of *1001 Questions Answered About Trees* at his fingertips for ready reference. Perhaps, then, his grandson's questions would not have seemed so "plaguy" after all.

Here is a book, written in understandable language, that is designed to help satisfy the inquisitive mind of the forester, conservationist, student of nature, and outdoor enthusiast. Moreover, it can also serve as a handy reference

for teachers who frequently need to add stimulating facts in keeping their lecture notes alive.

1001 Questions Answered About Trees is divided into six main topics:

1. History and Facts.—This topic deals principally with dendrology and with the odd and unusual facts relating to trees and to the forest regions of the world.

2. Forestry.—Foresters, in general, probably would be least interested in this section. The questions are designed to satisfy the inquiries of the layman and therefore deal with topics that are generally understood and within the knowledge of the profession.

3. Home Trees. — This answers all sorts of practical questions that pertain to the planting and care of trees for landscaping and beautification of homes and cities.

4. Tree Products.—What is the most all-around useful kind of tree? What is lignin? What is bird's-eye or curly maple? These are a few samples of interesting questions that are answered in this topic. A good list of uses for American hardwoods is also included. Question 806 which asks, "Why do batters hold the bat with the label up?" replies, "So that the ball will strike the edge of the grain and send the ball faster and farther." This is a good reply as far as it goes, but every good ballplayer knows that if he doesn't hold the trade mark up, he is likely to be out the price of a new bat.

5. Tree Pests and Diseases.—This topic answers questions relating to the common pests incident to our shade and forest trees. It pays particular attention, for example, to the pine bark beetles, the white pine blister rust, Dutch elm disease, and the elm phloem necrosis. Questions are also answered regarding some of the practical aspects of tree surgery.

6. The Tree is a Living Thing.—This deals primarily with the physiology of trees expressed in lay terms. How does a tree grow? How does sap flow up through a a tree? How does a leaf make sugar? These are examples of some of the questions that are answered.

The book is well-indexed, and included with some of the key questions is a bibliography for those readers who wish to seek additional information regarding them. Certainly *1001 Questions Answered About Trees* can serve a very useful purpose in answering some of the "plaguy" questions besetting the forester as he meets the inquisitive public and in providing facts that he can use for his own personal satisfaction.

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Atlas of Forestry in New York

By Neil J. Stout. 95 pp. Illus. State University College of Forestry at Syracuse University, Syracuse, N. Y. $2.50.

The distinctive regional aspects of New York's forest areas have long been recognized, and generic terms such as "Adirondacks," "Southern Plateau," and "Lake Plains" are well established in the vocabulary of plant geographers, forest economists and other groups who deal with the state's natural resources.

Nevertheless, it has taken a junior staff member of the Department of Forestry Economics in the State University, College of Forestry at Syracuse, to carry out the job of dissecting the state into its ultimate components—9 major regions and within these, 52 subregions—each, as Dean Shirley says in his foreword, with certain unique features, yet each related to the whole economy of the state.

A mere recital of these features would be a dull and repetitious affair; but Mr. Stout has avoided this, in the layout, by inserting a wealth of illustrative material which includes a series of excellent photographs along the page margins, and a multiplicity of both conventional and "jig saw" maps. Good organization of his text and considerable skill in writing have done the rest, to make this a treatise of unique interest, valuable equally for the practicing forester, who will recognize in some obscure subregion the accurate delineation of the locale where he planted trees or cruised timber, and for the layman who doesn't know anything about the subject but is willing to accept education presented in a clear and entertaining form. Statistical tables are neatly tucked away at the back of the book.

It is true, that in order to avoid repetition, Mr. Stout has been obliged to grasp the other horn of the dilemma and, as an example, in describing the 11 subregions of the Appalachian Highlands he makes mention in but one or two subregions of features that are more or less common to all, such as: "a close pattern of alternating fields and woodlots mark the countryside"; "owners still permit a good deal of destructive cutting by timber buyers"; "some farmers are taking an interest in Christmas tree culture"; "nearly half the land that was once used for farming is no longer used for this purpose"; "land acquisition by the State has continued from the early 1930's until recent years." All these are true, generally, of so large a part of the entire region that their validity as distinguishing characteristics of particular subregions may be questioned.

On the other hand, the author has been remarkably discerning in pinpointing certain features that are of genuine local flavor and significance, e.g., the furniture industry at Jamestown "established by Scandinavian cabinetmakers"; the factor of the petroleum deposits and their exploitation, which serves to justify recognition of a very limited subregion in the southwestern portion; differing agricultural practices in specified localities; the rather isolated occurrence of native red pine in the Chemung subregion; and the impact of the Otsego Forest Products Cooperative Association in two of the eastern subregions. The description of forest types as they vary from one subregion to another, under the influence of physical features and

land-use history, and the relationship between the timber resource and local wood-using industries are likewise well drawn and perceptive.

Some of the basic data and concepts, as the author acknowedges, stem from the Forest Survey report "The Timber Resources of New York," to which, in a sense it is a sequel; and a study of the one will increase the reader's understanding and appreciation of the other. This does not detract, however, in any way from the credit due the author for the original treatment and painstaking independent research which have gone into producing the *Atlas of Forestry*.

Incidental intelligence: the *Atlas* has an outside dimension of 11 by 14¼ inches and thus, unlike many of its kin, fits nicely into a standard legal-size file cabinet.

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Publications of Interest

The National Wildlife Federation has announced publication of a new booklet, *Our Growing Water Problems*, by R. G. Lynch.

The 60-page publication treats, on a national scale, the complex problems of managing public water resources for diverse and conflicting needs of a rapidly expanding human population. In obtaining material, the author interviewed informed sources in all regions and states.

Lynch discusses confusion, water trouble, and use and supply. This is followed by chapters on remedies and water laws, including a discussion of a "model act." The booklet then outlines waste disposal, status of the water supply situation in five regions of the U. S., and concludes with comments and observations.

Lynch, a veteran newspaperman on the *Milwaukee Journal*, specializes in reporting in the field of natural resource conservation.

Single copies may be obtained without charge from National Wildlife Federation, 232 Carroll St., N. W., Washington 12, D. C.

Current Literature

Compiled by MARTHA MEELIG, *Librarian, State University College of Forestry at Syracuse University*
Range Management Section Compiled by NELLIE G. LARSON, *Library, U. S. Department of Agriculture*

General

Exotic Forest Trees in New Zealand. By G. C. Weston. 103 pp. Illus. New Zealand Forest Serv., Wellington. Bul. No. 13.

Forest Regions of Canada. By J. S. Rowe. 71 pp. Maps. Canada Dept. of Northern Affairs and Nat'l. Resources, Ottawa. 1959. Bul. No. 123. $1.00.

An Investigation and Study of Chinese Tallow Tree in Taiwan. Summary in English. By Wei-Chih Lin and others. 37 pp. Taiwan Forestry Research Institute, Taipei, Taiwan, China. 1958. Bul. No. 57.

The Louisiana Forest Industry; Its Economic Importance and Growth. By F. L. Corty. 19 pp. Illus. Louisiana State Univ. & Agric. and Mech. College. 1959. Agric. Expt. Sta. Bul. No. 521.

Trees, Shrubs and Vines; A Pictorial Guide to the Ornamental Woody Plants of the Northeastern United States exclusive of Conifers. By A. T. Viertel. Illus. State Univ. College of Forestry, Syracuse, N. Y. 1959. Bul. No. 43. $1.25.

Christmas Trees

How We Buy Christmas Trees in Nebraska. By Walter Bagley and Ernest Feder. 29 pp. Illus. Nebraska Agric. Expt. Sta., Lincoln. 1958.

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Watershed Management Problems in the Rocky Mountain Region. By E. L. Packer. 28 pp. Illus. Intermountain Forest and Range Expt. Sta., Ogden, Utah. 1959. Research Paper No. 57.

Forest Management

Cutting Practice Demonstrations in Upland Hardwoods. By W. T. Plass and J. W. Greth. 13 pp. Illus. Central States Forest Expt. Sta., Columbus, Ohio. 1959. Tech Paper No. 162.

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Forest Resources

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Biennial Election

Ballots for the regular biennial election were sent to over 11,000 voting members of the Society in mid-October. Those ballots will be counted on December 5 and the newly elected officers and Council will take office January 1, 1960 for a 2-year term. Lists of nominees have appeared in Society Affairs monthly as received in the Society office.

Nominees for President

Charles A. Connaughton. Regional forester, U. S. Forest Service, San Francisco, Calif.

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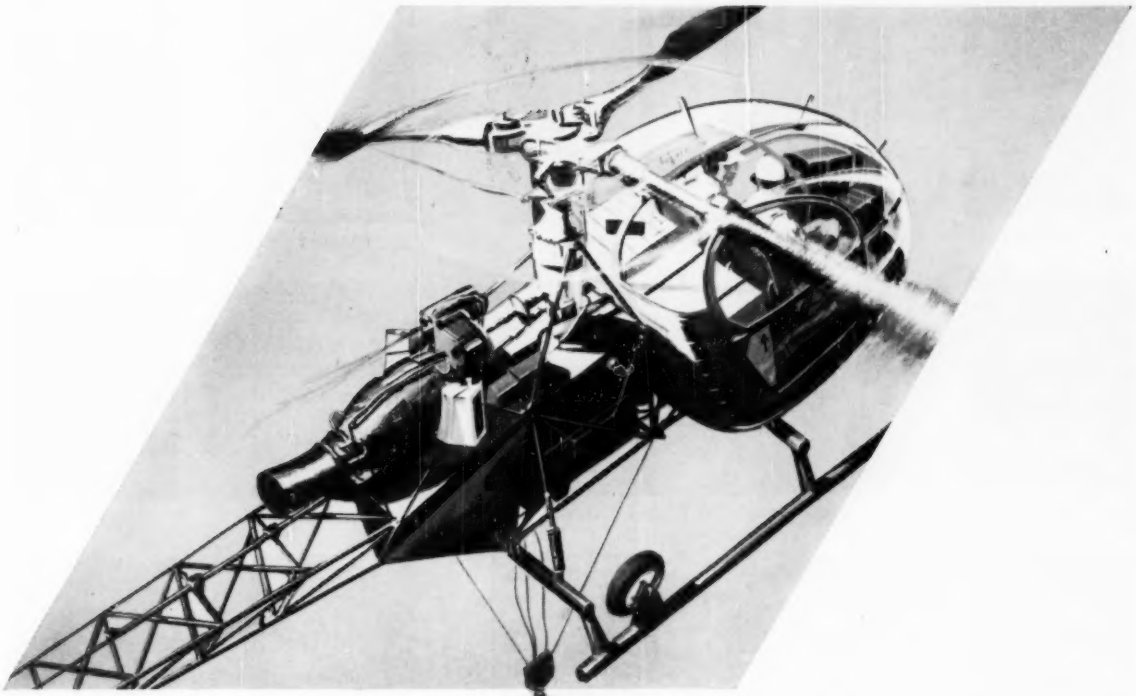

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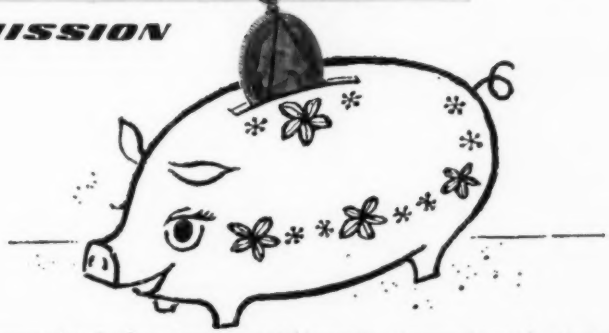

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Kenneth E. Barraclough. Extension forester, Cooperative Extension Service, University of New Hampshire, Durham, N. H.

William C. Bramble. Head, Department of Forestry and Conservation, Purdue University, Lafayette, Ind.

Sture T. Carlson. Chief, Branch of Park Forest and Wildlife Protection, National Park Service, Washington, D. C.

James M. Case. Washington—field woodland conservationist, Southeastern States, Soil Conservation Service, Spartanburg, S. C.

Donald E. Clark. Regional forester, U. S. Forest Service, Denver, Colo.

Robert W. Cowlin. Director, Pacific Northwest Forest and Range Experiment Station, Portland, Ore.

Kenneth P. Davis. Professor of forest management and chairman of the Department of Forestry, School of Natural Resources, University of Michigan, Ann Arbor, Mich.

Murlyn B. Dickerman. Director, Lake States Forest Experiment Station, St. Paul, Minn.

George A. Garratt. Dean, School of Forestry, Yale University, New Haven, Conn.

William D. Hagenstein. Executive vice president, Industrial Forestry Association, Portland, Ore.

Albert G. Hall. Forestry relations counsel and consulting forester, Washington, D. C.

Svend O. Heiberg. Professor of silviculture, College of Forestry, Syracuse, N. Y.

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Horace R. Josephson. Director, Division of Forest Economics Research, U. S. Forest Service, Washington, D. C.

Clemens M. Kaufman. Director, School of Forestry, University of Florida, Gainesville, Fla.

Arthur W. Nelson, Jr. General manager, Timber Products Division, Champion Paper and Fibre Company, Hamilton, Ohio.

Harrod B. Newland. Assistant, Branch of Information and Education, Florida Forest Service, Tallahassee, Fla.

William M. Palmer, Jr. Vice president, Nebo Oil Company, Good Pine, La.

Richard J. Preston, Jr. Dean, School of Forestry, North Carolina State College, Raleigh, N. C.

Waller H. Reed. Chief forester, Collins Almanor Forest and Collins Pine Company, Chester, Calif.

Charles L. Tebbe. Regional forester, U. S. Forest Service, Missoula, Mont.

James K. Vessey. Regional forester, U. S. Forest Service, Atlanta, Ga.

Lloyd T. Webster. Supervisor, Department of Natural Resources, State of Washington, Olympia, Wash.

Harry R. Woodward. Director, South Dakota Department of Game, Fish and Parks, Pierre, S. Dak.

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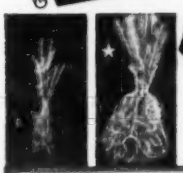

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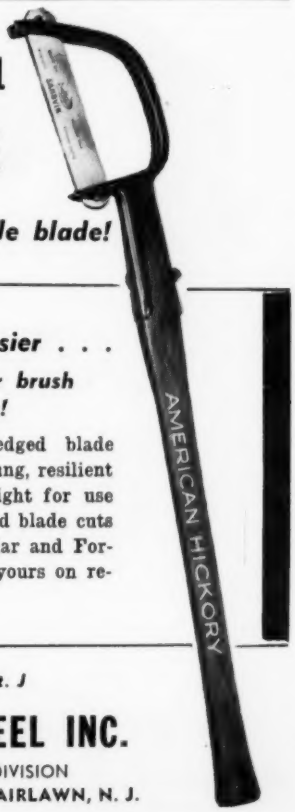

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Council's Column

Society Elections

With the 1959 Society election scheduled for December, this is an appropriate moment to take a look at the Society's established balloting procedures and to discuss questions sometimes raised in connection with them.

The Constitution provides that national elections shall be conducted under the Hare System of voting. This is one of a number of voting procedures often grouped under the term "proportional representation." Although most members understand the general purpose of this method as that of insuring appropriate representation to both majority and minority views within the membership, the exact details of the procedure may not be clear to many.

Briefly, the Hare System works as follows. Each voter casts a ballot for his preferred candidate by marking *1* opposite that candidate's name on the ballot. At the same time, he indicates his preference among all the remaining candidates, by marking *2, 3, 4, 5,* etc., opposite the names of the candidates whom he would prefer next after those given a higher ranking. Each number indicates what his vote would be *if* all candidates for whom he has shown higher preference cannot be elected or do not need his vote. Although the ballot thus shows relative preferences among all the candidates, it should be emphasized that each ballot is counted as a single vote for one candidate. In showing his preferences, the voter is indicating what his preference is under each of the various possible circumstances which the actual tally of votes may reveal as to who has a chance of being elected.

For example, suppose Messrs X, Y, and Z are running for President and that 8,000 votes are cast. In this case, 4,001 votes are required for election. On the basis of *first choice votes alone,* the initial tally shows: X: 3,550; Y: 3,075; Z: 1,375. It is apparent that Z cannot be elected. Therefore, the ballots on which Z was indicated as first choice are reviewed to determine who these voters indicated as their number *2* selection, in the event Mr. Z could not win. This review shows 1,050 of the voters who gave Mr. Z first choice voted for Mr. Y as their second choice, and 325 chose Mr. X as their second choice. These votes are then added to X and Y's totals giving the following result: Mr. X: 3,550 + 325 = 3,875; Mr. Y: 3,075 + 1,050 = 4,125; Mr. Y is therefore declared elected.

Note that even though the voter may indicate his order of preference among *all* candidates, his vote is actually counted for only *one* candidate. Similarly, in the case of a Council election where there are nine vacancies, the voter may show his preference among a much larger number of can-

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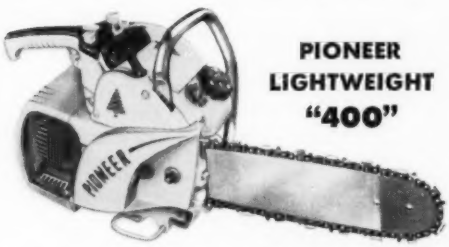

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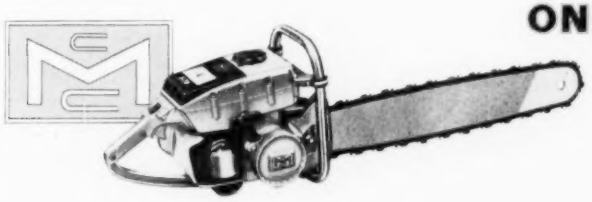

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TABLE 1.—DISTRIBUTION OF COUNCIL AND MEMBERSHIP BY EMPLOYING AGENCY

Employing agency	1940-49 Membership[1]	1940-49 Council	1950-59 Membership[2]	1950-59 Council
	Percent			
Federal	48	47	30	27
State	15	13	14	13
Private	19	16	30	27
Education	8	22	5	29
Retired & other	10	2	21	4
Total	100	100	100	100

[1]Average of 1937 and 1950.
[2]As of January 1953.

TABLE 2.—DISTRIBUTION OF COUNCIL AND MEMBERSHIP BY THREE MAJOR EMPLOYMENT GROUPS

Employing agency	1940-49 Membership	1940-49 Council	1950-59 Membership	1950-59 Council
	Percent			
Federal	58	62	42	40
State	19	18	18	20
Private	23	20	40	40
Total	100	100	100	100

didates, but his ballot will actually be counted in favor of only one man.

The principle of the system is thus relatively simple although the tabulating of the vote becomes laborious. The tellers who undertake this exacting job for the Society every two years deserve a vote of thanks from the rest of us which they seldom in fact receive!

How does this system of voting work out? Does it really serve its purpose of insuring that the final results of the election will reflect both majority and minority views? In one form or another this question is often raised by members. For example, the view is sometimes expressed that some of the smaller sections "are never represented on the Council," or that members from this employing agency or that dominate the voting. Sophisticated statistical analysis of these questions is beyond the scope of this column (and the columnist!), but some findings of a preliminary study of past SAF Council election history may be of interest to members. The ten elections from 1940-1941 to 1958-1959 inclusive were used as the statistical basis.

Distribution of the Council among Sections.—Of the 90 Council terms involved, the maximum number voted to any Section was 11 (to California[1]), and the minimum was none (to Intermountain). To test the question of lack of representation of small Sections, the Sections were ranked (1) as to average number of members during the 20-year period 1940-1959, and (2) as to number of Council terms voted to the Section during the same period. These two ranks were then compared for each Section. Eight Sections showed equal or nearly equal ranks for both average size of section and number of Council terms. Six Sections[2] ranked higher (by more than one rank) in size than they did in number of Council terms. These Sections might thus be considered as having been "underrepresented" during the 20-year period. Six other Sections[3] ranked lower (by more than one rank) in size than they did in number of Council terms. These Sections might thus be consid-

[1]Northern California and Southern California Sections considered as a single Section because they are not separated in the available tabulations of membership for the earlier part of the period in question.

[2]Columbia River, Allegheny, Appalachian, Central, Upper Mississippi Valley, Intermountain.

[3]Wisconsin-Michigan, Puget Sound, Inland Empire, Northern Rocky Mountain, Southwestern, Washington.

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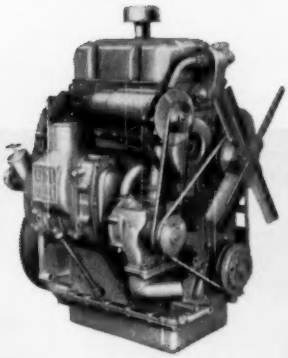

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In building construction, logging, public works and other industrial fields, the new "440ICD" is now daily proving its right to the claim of . . .

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John Deere Industrial Division, Dept. 2087, Moline, Illinois

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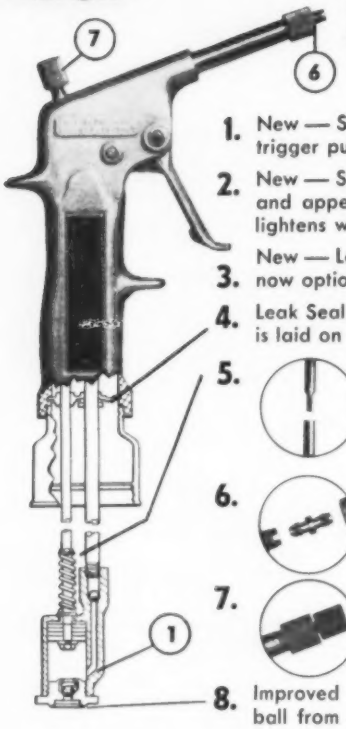
and Increased Efficiency

NEW D-103
NEL-SPOT
Marking Gun



1. New — Smaller cylinder and piston — ease trigger pull 25% — use less paint.
2. New — Shorter barrel — for better balance and appearance — easier handling in brush, lightens weight and reduces friction.
3. New — Larger nozzle sizes (.025 and .030) now optional to further ease trigger pull.
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TREE MARKING PAINT

Non-settling, non-skinning, Nelson paint eliminates stirring and straining — avoids plugged guns — saves part-cans thrown away. Packed in *quarts** which screw direct to the gun, it saves time in messy transfers in the woods.

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Quality is controlled to assure consistent high quality in every shipment — and you save every way when you mark trees with this combination of better paint, better gun, and count your costs in *more marks per gallon*, and *more trees per day*.

* Also available in gallons for Nel-Spot Back Pack —fives and 55 gal. drums

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ered as "over-represented." Among the 20 Sections, the average size rank of the "under-represented" Sections was 8; that of the "over-represented" Sections was 15.

Thus, for the two decades under study, this method of analysis suggests that smaller Sections have averaged somewhat more than a proportionate share of Council terms, while the larger Sections have averaged a somewhat less than proportionate share of such terms. Thus at least adequate representation appears to have been given to geographic minorities.

Distribution of the Council by employing agency.—Because of the drastic shifts which have taken place during the last 20 years in the distribution of members among employing agencies, the data were divided into two 10-year periods. For the two periods of 5 terms each, the average membership distribution and Council distribution were as shown in Table 1.

The data show an obvious bias in favor of Council candidates from forestry schools. Probably this is due to the fact that the average senior faculty member is better known to more people than his non-academic colleagues. Leaving out the "Education" and "Other" groups, the data can be recomputed yielding that shown in Table 2.

In both sample periods the agreement between proportion of members and proportion of Council terms is remarkable.

Although the foregoing analysis is sketchy, the figures suggest that election procedures have been doing a pretty good job of insuring representation on the Council of the varied interests and points of view contained within the Society.

But much more significant than these statistics of representation is the record of Council actions over the last two decades. Study of that record shows a remarkable proportion of unanimous Council actions and very few occasions when the body was sharply split. This indicates that, once elected, Council members serve not as representatives of particular sectional or other interests but as truly national officers, acting on behalf of the Society as a whole. That the election procedure and the judgment of the voting membership resulted in a series of Councils with this kind of viewpoint suggests that both the procedure and the judgment to which it gives expression are serving the Society well.

HENRY J. VAUX

SAF Represented at National Conference on Accrediting

Under the sponsorship of the National Commission on Accrediting, a meeting was held in Washington, D. C. on October 6 and 7, attended by representatives of the several regional educational associations, the professional accrediting societies, and others involved in accreditation in higher education.

More than one hundred participants represented 51 organizations and agencies at the conference. The Society of American Foresters was represented by Frank H. Kaufert of the University of Minnesota, chairman of the SAF Committee for the Advancement of Forestry Education, and by Henry Clepper, SAF executive secretary.

President Albert T. Jorgensen of the National Commission presided; he is president of the University of Connecticut. The conference was arranged by William K. Selden, executive secretary of the National Commission, whose headquarters are in Washington, D. C.

The purpose of the conference was to discuss the report of an earlier conference on accrediting, also sponsored by the National Commission, and to consider other matters relating to accrediting procedures and techniques.

Ten conclusions and recommendations adopted by the first conference were discussed by the conferees on October 6 and 7, as follows:

1. The recognized accrediting agencies not only should continue to be concerned with the maintenance of minimum standards of educational practice and performance in colleges and universities but also should assume greater responsibility for assisting institutions in their self-improvement.

2. In the process of aiding institutional self-improvement, accrediting agencies should encourage and assist in the collection of important comparative data for institutions to employ in their self-studies. Accrediting agencies also should aid in providing "bench-marks" against which individual institutions may compare their own performance.

3. Consideration should be given to the employment of an agency, such as the Office of Statistical Information and Research of the American Council on Education, to collect from the colleges and universities various types of objective or factual data which can be used by accrediting agencies, and by the institutions themselves in making self-studies.

4. Accrediting agencies should be invited to consider the possibility of establishing and publishing, or citing, degrees or gradations of institutional excellence within appropriate categories of institutions.

5. Great care must be exercised by accrediting agencies to assure that the use of comparative data, the standards for evaluation, and the means of assisting institutions in self-improvement do not hamper well-conceived experimentation and innovation.

6. Those institutional attributes which most directly affect the educational consequences or products of institutions should receive primary attention in accrediting, whereas such factors as business procedures, finances and administrative organizations should be viewed as supporting attributes to the main purposes of an educational institution and should be evaluated in terms of how effectively they contribute to the attainment of these purposes.

7. The facets of institutional quality which should receive primary consideration in evaluation and accrediting are: (a) objectives, (b) curriculum, (c) faculty, (d) teaching, (e) students, (f) institutional research, and (g) library.

8. The interview and related observational procedures, as presently used in accrediting, should themselves be carefully studied and should be supported by objective data wherever appropriate and feasible.

9. Continued research on the criteria, instruments, methods and techniques employed in the accreditation and evaluation of institutions should be encouraged. Constant attention should be given on the part of all accrediting agencies to the maintenance of high and appropriate standards of evaluating educational practices.

10. The National Commission on Accrediting should assume leadership in pressing for appropriate definitions of levels of educational excellence and in encouraging studies leading to more adequate systems of reporting to the public.

In general, the foregoing ten recommendations met with approval, although there were doubts expressed as to the practicality and value of numbers *4* and *10*. In behalf of the Society of American Foresters, Dr. Kaufert explained the difficulties encountered by the Council of the Society in attempting to classify schools of forestry on the basis of distinction. He pointed out that the Society subsequently abandoned the grading of schools by classes of distinction, and now simply lists the institutions offering professional programs in forestry as "accredited" and "not accredited." This is the procedure likewise followed by most of the professional societies engaged in accrediting.

Among the professions represented at the conference, in addition to forestry, were architecture, business administration, nursing, theology, law, chemistry, journalism, pharmacy, dentistry, library science, medicine, optometry, landscape architecture, social work, and music.

The National Commission recognizes 22 associations and societies as qualified in professional accreditation.

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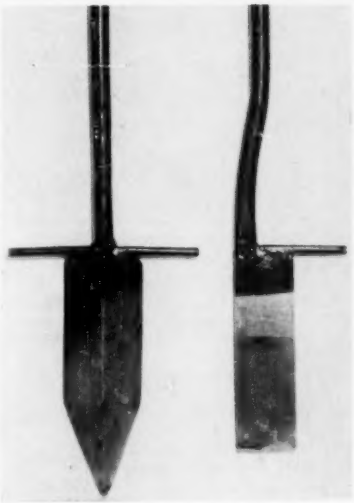

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Forestry, represented by the Society of American Foresters, is the only professional agency recognized in the field of natural resources management.

A book by Dr. Selden of the National Commission with the title *Accreditation: A Struggle over Standards in Higher Education* has been scheduled for publication by Harper and Brothers at the end of this year.

Wisconsin-Michigan Section Meets

The annual summer field meeting of the Wisconsin-Michigan Section was held September 11 and 12, 1959, at Marquette, Mich. Serving as host was the Chippewa Chapter under Harold C. Nygren, chairman. Carl Arbogast, Jr., was general chairman in charge of program and arrangements.

This was the first meeting held since the election of new officers last spring: D. J. Mackie, chairman; B. M. Stout, vice chairman; and R. F. Patton, secretary-treasurer. Friday afternoon was devoted to committee meetings, a short business meeting, and an orientation discussion by Carl Arbogast, Jr., concerning research on the Dukes Experimental Forest. The evening banquet was, appropriately, a lake trout dinner, after which Jean Wirth, editor of the Escanaba *Daily Press*, recounted a number of interesting, and sometimes very amusing, items of interest in the historical development of lumbering and forestry in the region from his gleanings through old newspaper files.

Saturday morning was devoted to a tour of either the Cliffs-Dow Chemical Plant or, for the great majority of the foresters in attendance, tours on the Dukes Experimental Forest, southeast of Marquette. Members had their choice of a general tour of the Dukes Experimental Forest, a tour of experimental cuttings concerned with northern hardwoods management, or of a tour of experiments on management of the swamp conifer types.

SAF Log Grade Committee Appointed

At the authorization of the Council a Log Grade Committee has been formed in the Division of Forest Products. The activities of the Committee will be to help the Society popularize the valuable grade work that has been done and to encourage more efforts toward a better knowledge and understanding of this important phase of forest utilization.

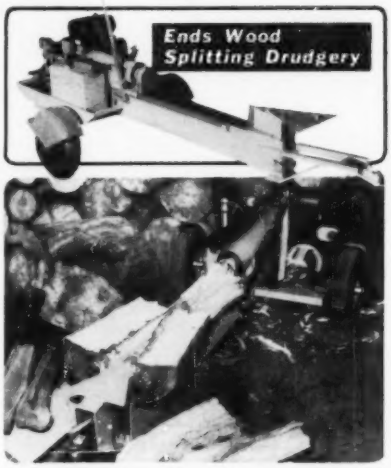
Bernard M. Granum, chairman of the Division, has announced the following membership on the Committee: C. R. Lockard, chairman, Division of Forest Products, U. S. Forest Service, Washington, D. C.; Henry Wersching, Indian Service, Department of the Interior, Washington, D. C.; V. W. Cothern, Southern Pine Association, New Orleans, La.; George Stenzel, College of Forestry, University of Washington, Seattle; Woodrow W. King, Forestry Investigations, TVA, Norris, Tenn.; Oliver P. Wallace, Department of Forestry, University of New Hampshire, Durham; Elbert C. Cleveland, Boise Cascade Corporation, Boise, Idaho; John Putnam, U. S. Forest Service, Stoneville, Miss.; Thomas Orr, Weyerhaeuser Co., Klamath Falls, Ore.; and Edwin Zaidliez, Bureau of Land Management, Portland, Ore.

Coming Events

Kentucky-Tennessee Section

The Kentucky-Tennessee Section will hold its annual winter meeting at the Andrew Johnson Hotel, Knoxville, Tenn., December 4-5. General theme: Forestry Schools and Education in Kentucky and Tennessee.

LICKITY LOG SPLITTER



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Alaska Section Holds Organization Meeting

The Alaska Section, the 22nd Section of the Society, held its first meeting in Juneau on September 25. Prior to its organization as a Section it was the Alaska Chapter of the Puget Sound Section.

At the business session, the Section bylaws were adopted for the approval of the SAF Council.

Carlos T. Brown of the U. S. Forest Service presided at this session as chairman *pro tem*. He, together with Von Johnson of the Bureau of Land Management, Anchorage, and Frank Lound of the Ketchikan Pulp Company, served as temporary chairman, vice chairman, and secretary.

The Section starts its existence with a total of 81 members, and hopes to have more than 100 members by the end of the year.

At the Section's dinner B. Frank Heintzleman, ex-regional forester of the U. S. Forest Service in Alaska and former territorial governor, was the principal speaker. Henry Clepper, SAF executive secretary, also gave a talk on the forestry profession in America.

OLYMPIC ELK on a Weyerhaeuser tree farm where timber is grown as a continuous crop. Through planned harvesting, reforestation and protection practices, our lands will provide wood, water, wildlife, payrolls and other benefits forever.

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Announcement

The name Weyerhaeuser Timber Company has been changed to Weyerhaeuser Company. Simultaneously, the new symbol below was adopted to identify our products and our operations throughout the United States.

While timber is our basic raw material, the word *timber* in our corporate name was not descriptive of the full scope of our business activities.

Today, we produce a long and varied list of forest products, many born of our own research and development work. Other products will follow as we carry out our policy of converting timber crops to their highest use and maximum value.

As the golden rays of the evening sun accent the beauty of a western tree farm, a herd of elk pauses by a placid stream. The stately animals, flowing water and forested hillsides blend into a scene that portrays the abundant values provided by Weyerhaeuser tree farms in the Pacific Northwest.

These are productive lands, rich in their rewards to man. They produce wood for lumber, plywood and other building products we manufacture for the nation's use... as well as wood fibers for our chemical pulps, paperboards, shipping containers, folding boxes, milk cartons and specialty items. In addition, our timberlands afford excellent shelter and forage for wildlife and supply water for lakes and streams year after year.

Such are the benefits of careful forest management... an endless supply of wood for essential products, and perpetuation of watershed, scenic and recreational values on our lands. *Write us at Box A, Tacoma, Washington, for a free booklet,* ***Forest Products from Tree Farm to You.***

Weyerhaeuser Company

Producers of lumber, plywood, pulp, paperboard, shipping containers, folding boxes, milk cartons, hardboard, particle board, Ply-Veneer, bark and wood fiber products.

New officers, elected to serve until December 31, 1960, are:

Chairman, Von Johnson, Bureau of Land Management, Anchorage.

Vice Chairman, John Sandor, U. S. Forest Service, Juneau.

Secretary-treasurer, Philip A. Heyn, U. S. Forest Service, Anchorage.

Upper Mississippi Valley Holds Meeting

The autumn meeting of the Upper Mississippi Valley Section was held at Walker, Minn. on September 18 and 19. The group of about 150 foresters toured the Badoura Nursery, the largest nursery operated by the Minnesota State Forest Service, and the Badoura forest fire area which blackened some 14,000 acres of forest land on May 1 of this year. A review of the suppression action taken in the fire was given the following morning by the State Forest Service.

Frank Fredrickson, Chairman, officiated at the business meeting. The next meeting is scheduled in the McGregor-Dubuque area in Northeastern Iowa some time in the latter part of March or April.

Inactive Status

Society members temporarily serving in the armed forces may request that they be placed on inactive status. Inactive members do not receive copies of the JOURNAL OF FORESTRY, nor are they permitted to vote. They are considered as members of the Society and may be restored to active status upon request when returning to civilian life, with payment of current dues only.

Retired Status

Members and Fellows of 20 years or more standing who retire from full-time employment, either in forestry or other fields, with consequent substantial reduction in income, may, upon application to the Council, continue as voting members. Their dues are remitted except for an annual charge of $5 should they desire to receive the JOURNAL OF FORESTRY and other Society publications.

Members granted such retired status in the Society must continue to pay Section dues in order to continue as Section members.

Subscription Rate Increased JOURNAL OF FORESTRY

Effective January 1, 1960 annual subscription rate to the JOURNAL OF FORESTRY will be increased to $9. Foreign postage ($1) and Canadian postage (50¢) remain the same.

Renewal and new subscriptions to the JOURNAL OF FORESTRY, beginning with the January 1960 issue, will be payable at the increased rate.

Horace E. Brinckerhoff (1884—1959)

Horace Everett Brinckerhoff, 75, former executive secretary of the American Pulpwood Association of New York City, died September 20.

Born February 16, 1884 in Mt. Vernon, N. Y., Mr. Brinckerhoff went to Cornell University, obtaining the B.S.A. degree in 1906.

Most of his early career was spent with pulp and paper companies and in consulting forest-engineering. He was with International Paper Company during the period 1927-1935, and in 1939 was appointed executive secretary of the American Pulpwood Association, which position he held until his retirement several years ago.

Ward Shepard (1887-1959)

Ward Shepard, 72, of Oakton, Va. died September 13, 1959. He was born in Hicksville, Ohio on March 14, 1887.

After receiving the A. B. degree from Harvard College in 1910, he studied forestry at Harvard Forest, receiving the M. F. degree in 1913.

Entering the U. S. Forest Service in 1913 in the Southwest, he was given various field assignments, and later was transferred to the Washington, D. C. office for duty in public relations and in research.

He saw military service in World War I, having been appointed as listing officer for the 10th Engineer (Forestry) Regiment.

Returning to the Forest Service after the war, he left in 1930 to become associated with Gifford Pinchot, and later served as forester in the Office of Indian Affairs, U. S. Department of the Interior.

In the spring of 1936 he was named director of the Harvard Forest, which position he held until 1939. The following year he was on the staff of the Bureau of Agricultural Economics of the U. S. Department of Agriculture, and in 1946 was a consultant in the Department of the Interior.

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Mr. Shepard was the recipient of $500 offered by Charles Lathrop Pack for a prize essay "The Necessity for Realism in Forest Propoganda," published in the JOURNAL OF FORESTRY in 1927. He won another award of $1000 offered by Gifford Pinchot for a paper "Cooperative Control: a Proposed Solution to the Forest Problem," also published in the JOURNAL OF FORESTRY, in 1930.

He was also the author of the book *Food and Famine: The Challenge of Erosion*, published in 1945.

He was elected secretary of the Society of American Foresters for the year 1928, and was a member of the Council during the period 1934-1937. He was on the editorial board of the JOURNAL OF FORESTRY during 1927-1929.

For the past decade Mr. Shepard had been in poor health and had not been active in forestry.

Stephen N. Wyckoff (1891-1959)

Stephen N. Wyckoff, 68, of Berkeley, Calif., died of cancer on September 1.

Mr. Wyckoff was graduated at the University of California in 1914 with the B.Sc. degree, and later took graduate courses there.

He entered blister rust control work in California in 1919. Later he headed forestry activities in the western states for the Federal Bureau of Entomology and Plant Quarantine at Spokane, Wash.

Between 1936 and 1954 Mr. Wyckoff served as director of three western forest experiment stations. On his retirement in 1954, he was director of the California Station at Berkeley.

After leaving federal service, he helped found and headed the Forest Genetics Research Foundation at Berkeley, Calif.

Membership Applications and Advancements

Proposals for admission, advancement, and reinstatement received in the Society office during the month of September are listed below.

Action on the eligibility of those proposed for membership as listed below will be taken by the Council as of November 1959.

Communications from the voting members regarding the membership eligibility of these persons should be received in the Society office prior to that date.

Allegheny Section

Student Grade

PENNSYLVANIA STATE UNIVERSITY

Kaufman, R. L.

Junior Grade

Hanlen, P. J., Mgmt. Analyst, USFS, Darby, Pa. (Reinstatement).

Student Eligible for Automatic Advancement

PENNSYLVANIA STATE UNIVERSITY

Hopkins, H. R.

Member Grade

Hillgartner, G. G., Sr. Planner, N. J. Dept. of Cons. & Economic Development, Lambertville, N. J. (32R59).

Kohler, J. F., Service Forester, Pa. Dept. of Forests & Waters, Johnstown, Pa., Pa. State, BSF, 1954 (Junior 1954).

Affiliate Grade

Davis, R. W., Asst. State Firewarden, N. J. Dept. of Cons. & Economic Development, Trenton, N. J.

Associate Grade

Buell, M. F., Prof. of Botany, Rutgers Univ., New Brunswick, N. J.

Appalachian Section

Junior Grade

Students Eligible for Automatic Advancement

NORTH CAROLINA STATE COLLEGE

Byerly, R. D.	Jennings, J. S.
Eggler, J. A.	Thompson, E. F.

Affiliate Grade

Courtney, C. R., Asst. to the Chief Forester, Chesapeake Corp. of Va., West Point, Va.

Central States Section

Student Eligible for Automatic Advancement

PURDUE UNIVERSITY

Reed, P. T.

Columbia River Section

Junior Grade

Ackerman, J. M., Forester, USFS, Estacada, Ore., State Univ. of N. Y., BSF, 1957.

Affiliate Grade

Utley, J. T., Forester, USFS, Tiller, Ore.

Gulf States Section

Junior Grade

Students Eligible for Automatic Advancement

LOUISIANA POLYTECHNIC INSTITUTE

Carruth, T. J.	McKissack, W. D.
Commeaux, G. D.	Shows, R. D.
Elkin, M. D.	Slayton, S. H.
Erwin, L. T.	Stagg, C. J.

LOUISIANA STATE UNIVERSITY

Caillouet, C. W.	Legg, J. E.
Dubarry, A. P.	Mattison, J. B.
Kromer, J. A.	Robinson, W. M.

Affiliate Grade

Derks, J. A. Forester, USFS, Hattiesburg, Miss.

McCormack, V. H., Forester, U. S. Dept. of Agric., Holly Springs, Miss.

Inland Empire Section

Junior Grade

Students Eligible for Automatic Advancement

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GEORGIA

Clearing about 3,000 acres of woods that had been destroyed by fire, this Caterpillar D4 Tractor with Rome Disk Harrow averaged 7 acres production per 8-hour day. Site: near Savannah, Ga. Most of the acreage required only a single cut; the remainder, a double cut. "The D4 and harrow are doing a wonderful job," said B. Ferrere, Woods Foreman of the Atlantic Creosote Co., Savannah.

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UNIVERSITY OF IDAHO

Bruckner, R. A. Coats, R. T.

Associate Grade

Bruce, R. W., Acting Jr. Agric. Economist, State College of Wash., Pullman, Wash.

Intermountain Section

Junior Grade

Terrill, R. B., Forester, USFS, Price, Utah, Univ. of Idaho, BSF, 1949.

Kentucky-Tennessee Section

Junior Grade

Hamman, A. S., Forestry Asst., Hiwassee Land Co., Kingston, Tenn., Mich. College of Mining & Tech., BSF, 1956.

Member Grade

Jiles, R. A., Staff Forester, TVA Forestry Bldg., Norris, Tenn., L. P. I., BSF, 1948, Duke Univ., MF, 1956 (Junior 1954).

New England Section

Junior Grade

Hoadley, R. B., Wood Tech. Proj. Supv., Yale School of Forestry, New Haven, Conn. (Reinstatement).

Students Eligible for Automatic Advancement

UNIVERSITY OF MAINE

Bauer, R. E. Stewart, B.E.

UNIVERSITY OF MASSACHUSETTS

Hoyle, M. C. Strathdee, D. B.

New York Section

Junior Grade

Zaremba, J., Asst. Prof., Dept. of Forest Economics, Syracuse Univ., Syracuse, N. Y. (Reinstatement).

Northern California Section

Junior Grade

Lindquist, J. L., Asst. Specialist, Univ. of Calif., Berkeley, Calif., Univ. of Minn., BSF, 1951, MF, 1958.

Member Grade

Buck, J. M., Forester, USFS, San Francisco, Calif. (Reinstatement).

Ozark Section

Affiliate Grade

Storie, H. E., Asst. Forester, Dierks Forests, Inc., Smithville, Okla.

Puget Sound Section

Junior Grade

Johnson, N. E., Forest Entomologist, Weyerhaeuser Co., Centralia, Wash. (Reinstatement).

McGonagill, K. L., Forester, USFS, Quinault, Wash., Univ. of Wash., BSF, 1950.

Southeastern Section

Student Grade

UNIVERSITY OF GEORGIA

Welch, W. E. (Reinstatement).

Junior Grade

Czuhai, E., Forester, Piedmont Natl. Wildlife Refuge, Round Oak, Ga., Mich. State, BSF, 1950.

Lanta, J. E., Area Forester, Gair Woodlands Corp., Ludowici, Ga., W. Va. Univ., BSF, 1957.

Students Eligible for Automatic Advancement

ALABAMA POLYTECHNIC INSTITUTE

Burns, S. E. J. Hamilton, R. N.

UNIVERSITY OF FLORIDA

Meskimen, G. F. Shealy, G. N.

UNIVERSITY OF GEORGIA

Beach, R. E. Mauldin, A. T.
Beasley, J. R. Moss, W. T.
Chick, P. P. Parker, F. O.
Durham, W. G. Smith, T. A.
Eadie, J. R. Staten, G. F.
Flanders, G. W. Stokes, C. G.
Link, D. D. Strickland, R. K.
Marcaurelle, R. L. Welch, W. E.

Affiliate Grade

Cantrell, C. T., Dist. Ranger, Ga. Forestry Comm., Gainesville, Ga.

Pitts, D. W., Area Forester, Fla. Forest Service, Milton, Fla.

Powell, J. G., Mgmt. Forester, Dept. of Cons., Brewton, Ala.

Associate Grade

Kaul, H., President, Kaul Lbr. Co., Birmingham, Ala.

Upper Mississippi Valley Section

Student Grade

IOWA STATE UNIVERSITY

Anderson, P. O. Ficken, L. D.
Farris, W. A. Duskin, D. L.
Schlachtenhaufen, E. C.

Students Eligible for Automatic Advancement

IOWA STATE UNIVERSITY

Anderson, D. P. Binger, C. E.
Barnes, G. D. Johnson, R. W.

Wisconsin-Michigan Section

Junior Grade

Glaser, D. E., Asst. Nurseryman, USFS, Wellston, Mich., Iowa State Univ., BSF, 1951.

Wilkinson, R. C., Research Asst., Univ. of Wis., Madison, Wis., Mich. State, BSF, 1949, MS, 1950.

Students Eligible for Automatic Advancement

MICHIGAN STATE UNIVERSITY

Blattner, F. J. Hoffer, R. M.
Bright, J. N. Holemo, F. J.
Coil, J. R. Kazmierczak, R. V.
Eabe, L. E. Konkol, D. W.
Eidenberger, R. L. Liimakka, A. W.
Filius, D. A. Moss, R. G.
Fowler, F. C. Salo, K. W.
Frame, J. R. Smith, D. J.
Grebasch, G. C. Swartz, E. L.
Grieves, P. C. Terhune, W. S.
Hatch, W. R. Toby, W. J.
Healy, S. L. Wheatley, G. N.

UNIVERSITY OF MICHIGAN

Eckart, E. E. Rogers, J. W.
Flory, R. C. Schumann, D. R.
Whaley, R. S.

Member Grade

Conover, D. F., Teaching Forest Pathology, Wis. State College, Oshkosh, Wis. (Junior 1952).

No Section

Corresponding Grade

Inal, S., Director, Univ. of Istanbul, Istanbul, Turkey.

Lee, C. S., Asst. Forestry Technician, Minister of Agric. & Forestry, Seoul, Korea.

Paik, Y. K., Gov. Officer, Korea Gov., Seoul, Korea.

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Forestry News

Lumber Consumption, Exports, Imports

The National Lumber Manufacturers Association reports that lumber consumption, including exports, totaled 10.9 billion board feet during the second quarter of 1959—up 24 percent from the first quarter and nearly 15 percent higher than the second quarter last year, according to latest estimates. Third quarter consumption is expected to total 10.6 billion board feet—about 3 percent below the second quarter but 2 percent above the year-ago level.

Pesticide Research Receives Further Impetus

President Eisenhower signed into law in September a bill increasing by nine times the annual authorization for pesticide research conducted by the Fish and Wildlife Service. The measure raises from $280,000 to $2,565,000 the appropriations ceiling on this program. The increase is expected to bring about a change in emphasis from research to determine the effects of pesticides on fish and wildlife to research aimed at developing new materials and methods for control of forest and other pests with a minimum harmful effect on fish and wildlife.

Turkish Forester Completes Recreational Studies in U. S.

Mr. Vedat Avni Erder, member of the Turkish Forest Service, recently has returned to Turkey after two years of intensive study among important national forest and park recreation areas and institutions of the United States.

In 1957, the Turkish Forest Service chose, by competitive examination, one of its foresters for assignment to some foreign country for training in forest recreation and national park work. Erder won the examination and chose western United States because of its long history in park and forest recreational land use and its similarity to Turkish climatic and topographic conditions.

After six months of orientation and English language studies in Georgetown and American (Washington, D. C.) Universities, Erder visited many western national parks and monuments under guidance of the National Park Service. Early in 1958 he attended the National Park Service's 18th General Administration Training Course in Santa Fe, New Mexico. Late in 1958 he attended the Park Service's In-Service-Training School in Yosemite National Park. From January to June 1959 he was a special student in Forest Recreation at Colorado State University. There he took course work and accompanied the senior spring tour of forest and park recreation and wildlife areas.

Christmas
Suggestions for Him

Forestry and Related Research in North America. 1955. A review of progress in forestry and related research during the past quarter-century and recommendations and goals for the next quarter-century. **Price postpaid $5.**

Forestry Terminology. 1958 edition. A glossary of technical terms used in forestry. Included are definitions of terms that the practicing forester uses in his daily work and encounters in forestry literature. A *must* for every forester's desk. **Price postpaid $3.50.**

Binder for JOURNAL OF FORESTRY. Holds 12 issues. Brown imitation leather, stiff board. Title stamped in gold foil on front cover and backbone. **Price $3.**

Forestry Handbook. 1955. 1201 pp., 744 illus., tables. All the working methods, techniques and vital data of on-the-ground forestry as practiced today in the United States and Canada. **Price postpaid $15.**

Forest Cover Types of North America. 1954 edition. Includes detailed description of approximately 250 North American forest types (exclusive of Mexico). A table lists common and botanical names of tree species and an index of forest types is included. **Price $1.**

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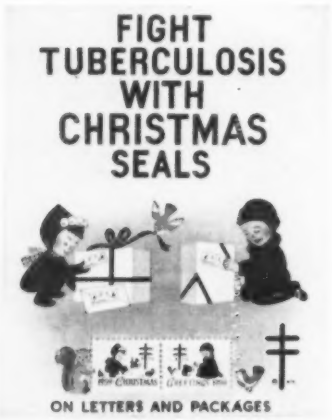

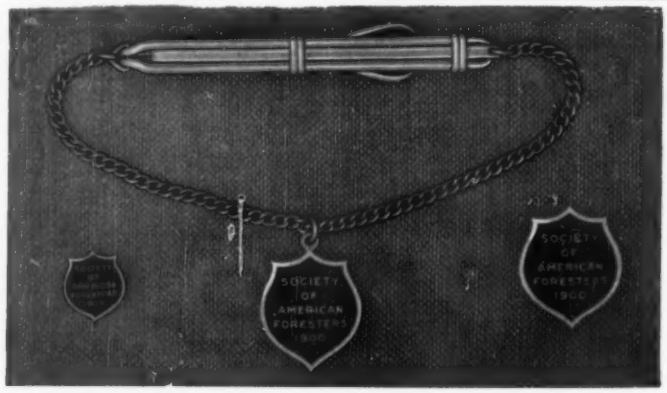

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Private & Industrial

Blair Heads Industrial Foresters Group

Rowland W. Blair, Manistee, Mich. was elected president of the Lake States Council of Industrial Foresters at a recent meeting of the group in Marquette, Mich. Blair, chief forester for Packaging Corporation of America, replaces B. L. Berklund of Port Edwards, Wis. as head of the group.

The Council is composed of technical foresters employed by pulp and paper, lumber, and veneer companies.

Other council officers and directors are: Bruce G. Buell, chief forester for Marathon Corp., Menasha, Wis.; E. S. Hurd, forester for Consolidated Water Power and Paper Co., Rhinelander, Wis.; and J. B. Millar, woodlands manager of Kimberly-Clark Corporation, Neenah, Wis. Mr. Berklund, forester for Nekoosa-Edwards Paper Co., becomes a member of the board of directors.

Public

Central States Researcher to Washington

Dr. Franklin G. Liming, leader of the Central States Forest Experiment Station's Columbia, Mo., Forest Research Center, has transferred to the Washington office of the U. S. Forest Service. He will assist the director of the Division of Forest Management Research and be in charge of research programs in regeneration and silviculture. In addition, he will handle an international forest tree seed exchange program and help complete a manual on silvics of forest trees.

Except for temporary assignments elsewhere, Liming has spent his entire Forest Service career at the Central States Station, chiefly in Missouri. A pioneer forest researcher in Missouri, Liming has played an important role in stimulating interest in forestry in the State, in promoting recognition of forest research, in building up a practical research program, and in encouraging a cooperative approach to the solution of Missouri's forest problems.

Liming is a member of the Society of American Foresters, Xi Sigma Pi, Sigma Xi and Phi Beta Kappa. A native Ohioan, Liming was educated at Ohio State University where he earned his doctorate in plant physiology.

FRANKLIN G. LIMING

National Park Service Officials Shifted

Promotions, transfers and retirements affecting 25 National Park Service employees were announced recently.

National Park Service Director Conrad L. Wirth said the personnel changes were made in accordance with the Department's promotion plan. They involve the following SAF members:

Lawrence F. Cook, chief of the Branch of Protection, Division of Ranger Activities will become chief of the Division of Ranger Activities in the Washington office.

Sture T. Carlson, regional chief of Park Forest and Wildlife Protection, Region Three, Santa Fe, will succeed Cook.

Harthon L. Bill, assistant regional director, Region Three, will become superintendent of Grand Teton National Park, Wyoming.

David H. Canfield, regional chief of operations, Region Three, Santa Fe, will retire in November.

John B. Dodd, assistant chief of the Branch of Park Forest and Wildlife Protection in the Washington office, will become assistant superintendent of Everglades National Park.

Fred H. Arnold, presently chief of the branch of Park Forest and Wildlife Protection in the Region One Office, Richmond, is being promoted to chief of the Region One Division of Ranger Activities.

Frank W. Childs, chief of the Branch of Park Forest and Wildlife Protection, Region Two, Omaha, will become chief of the Division of Ranger Activities, Region Two.

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Wheeler Completes Assignment in Cambodia

A recent task of Philip R. Wheeler, chief of the Division of Forest Economics, Southern Forest Experiment Station, was the development of plans for a survey of Cambodia's forest resource. His 30-day assignment in that country was requested of the U. S. Forest Service by the International Cooperation Administration.

Wheeler recommended the taking of data on about 400 ground sample plots, supplemented with information from several thousand plots established on existing aerial photographs. A survey is the essential first step toward increasing the present low income from Cambodia's 20 million forested acres, which are potentially rich in tropical hardwoods.

While in Cambodia, Wheeler visited the Forest of Angkor. Here elaborate temples of the Khmer civilization, which flourished and faded in the period 900-1432 A.D., have been grown over by trees now more than 10 feet in diameter. One theory of the disappearance of these people is that their irrigation water supply dwindled as forest cover was destroyed by unwise use. The original irrigation system is being rebuilt and supplied with water from a dam constructed with American funds.

Milodragovich Named Supervisor of Nezperce

John R. Milodragovich has been appointed supervisor of the Nezperce National Forest with headquarters in Grangeville, Idaho, according to an announcement by Regional Forester Chas. L. Tebbe, U. S. Forest Service, Missoula, Mont. Mr. Milodragovich succeeds the late Alva W. Blackerby.

Milodragovich has been serving as an assistant to the chief of the division of state and private forestry in the regional office at Missoula. A native of Butte, Mont., he graduated from Montana State University's School of Forestry, and began his career with the U. S. Forest Service on the Deerlodge and Kootenai National Forests prior to World War II.

Following service in the European theatre during the war, Milodragovich served again on the Deerlodge and Kootenai and in 1955 was promoted to assistant supervisor on the Helena National Forest. In 1957 he joined the regional office staff.

N.W. Forest Economics Chief Named

Dr. Carl A. Newport has been named chief of forest economics research at the Pacific Northwest Forest and Range Experiment Station, Director R. W. Cowlin of the U. S. Forest Service research unit announced in September.

Newport will take charge of the Station's studies of economic factors affecting production, marketing, and distribution of forest products in Oregon and Washington. Also under his supervision will be the regional phase of the nationwide Forest Survey. He fills a vacancy created by retirement of Floyd L. Moravets early this year.

Newport went to Portland from the Pacific Southwest Station in California, where he was in charge of marketing research.

CARL A. NEWPORT

Newport received a bachelor of science degree in forestry from the University of Michigan in 1948 and a master's degree from Oregon State College in 1950. In 1954 he obtained a doctorate in forest economics from New York State University College of Forestry at Syracuse.

During World War II he served 3 years in the Army Air Force. He is a member of the Society of American Foresters and honorary societies Xi Sigma Phi and Sigma Xi.

Chemistry Chief Named at Products Lab

Dr. Jerome F. Saeman has been appointed chief of the division of wood chemistry at the U. S. Forest Products Laboratory, Madison, Wis., succeeding Dr. Edward G. Locke, who became Laboratory director September 1.

Dr. Saeman was graduated from the University of Wisconsin as a chemist in 1937 and received his Ph.D. there in 1942. For the past two years he has been an assistant to the director of the division of forest products utilization research, Forest Service, Washington, D. C.

Products Lab Assistant Director Retires

L. J. Markwardt retired September 30 as assistant director of the Forest Products Laboratory, Madison, Wis. He plans to become a consultant for several industrial concerns in the forest products fields. His retirement followed by a month that of his professional associate, Dr. J. Alfred Hall, who was Laboratory director for the past 8 years.

A native of Iowa, Markwardt was graduated as a civil engineer from the University of Wisconsin. After a short term as assistant city engineer of Madison, he joined the staff of the Laboratory just two years after it had been founded by the Forest Service, U. S. Department of Agriculture, in cooperation with the University.

The diversified nature of his accomplishments has won him frequent recognition. In 1950, the American Society for Testing Materials elected him national president. Also in 1950, his alma mater awarded him an honorary citation for "eminent professional services and notable accomplishments in engineering and industrial fields." In 1957 the U. S. Department of Agriculture conferred on him its superior service award. He has represented the United States on several occasions at European meetings of world-wide research groups, such as the United Nations conferences on wood technology.

Markwardt holds appointments to the Building Materials Advisory Board and Research Advisory Board of the National Research Council—National

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Academy of Science. He is currently chairman of the U. S. program committee charged with the development of the technical forest products program for the Fifth World Forestry Congress..

He helped found and is a charter member of the Forest Products Research Society. Other affiliations include the American Society of Civil Engineers, the American Railway Engineering Association, the Society of American Foresters, National Society of Professional Engineers, American Association for the Advancement of Science, Tau Beta Pi, Sigma Xi, and Chi Epsilon.

O. K. Hutchison Transfers to Alaska

O. Keith Hutchison, Research Forester in economics at the Central States Forest Experiment Station, transferred to Juneau, Alaska, in September. He will head up Forest Survey work in the 49th State. A native of Oregon, Hutchison has been stationed at the Central States Station in Columbus, Ohio, for all but 2 of his 15 years with the U. S. Forest Service. Specializing in survey techniques, his assignments have ranged from Forest Survey field and photo work through marketing research and forest resource analysis to forest ownership studies.

Hutchison holds a bachelor's degree in forestry from Oregon State College and a master's degree in agricultural economics from Ohio State University. He is author of about a dozen technical publications.

Timber Chief Appointed

William H. Johnson has been appointed assistant regional forester in charge of the Division of Timber Management for the Northern Region of the U. S. Forest Service, according to an announcement by Chas. L. Tebbe, Regional Forester, Missoula, Mont. He will take over his duties November 1.

Johnson succeeds Axel J. Lindh who was transferred recently to the Washington office of the Forest Service as director of the Division of Land Use Adjustments.

Johnson goes to Missoula from Washington, D. C., where he has been supervisory administrative officer on the Internal Audit staff. Prior to his Washington assignment in November 1957, he served as assistant regional forester in charge of timber, recreation, and lands in the Alaska Region of the Forest Service with headquarters at Juneau.

Assigned to Hydrological Investigation

The reassignment of Harry R. Bryant was announced in September by Regional Forester J. Herbert Stone, U. S. Forest Service, Portland, Ore.

Bryant will move from the Willamette National Forest to the hydrological investigation section in the Division of Watershed Management in the regional office in Portland.

Bryant has been a highway engineer on the Willamette since 1955. He received his B.S. degree in Forest Engineering from Oregon State College in 1949 after serving in the Navy from 1944 to 1946. He entered the Forest Service in 1952 as an engineering aid on the Rogue River National Forest.

Joins Intermountain Staff

Alessio P. Caporaso commenced work in August at the Intermountain Forest and Range Experiment Station, according to Director Reed W. Bailey. Caporaso will assist E. V. Roberts, chief of the Station's Division of Forest Economics Research, and will be leader of the Forest Survey section.

Caporaso was on the staff of the Alaska Forest Research Center, Juneau, for the past 5 years. In World War II he served in the European Theatre with the 660th Topographic Engineers, U. S. Army.

A native of Connecticut, Caporaso was graduated from the School of Forestry, University of Idaho, in 1937, and has been working with the Forest Service since that time except for 3 years of military service.

Schools

Yale Receives Grant for Genetics Research

George A. Garratt, dean of the Yale School of Forestry, has announced that the National Science Foundation has given Yale a $53,200 grant to conduct forest tree genetics research.

Francois Mergen, assistant professor of forest genetics at Yale and acting

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director of the Yale Forestry Research Center at Valhalla, N. Y., from 1955 to 1957, will be in charge of the project which will be of five-year duration.

The grant will be used first, to provide the funds for the project, and secondly, to provide the salaries for two graduate-student assistantships.

The Yale project not only will delve extensively into the behavior of forest trees, Mergen said, but in using the services of forestry graduate students will provide training for young forest geneticists to continue basic research in the field over future years.

Studies will be conducted not only through controlled experiments in the Yale Forestry School's new Greeley Memorial Laboratory but in the testing areas of the Great Mountain Forest at Norfolk, Conn., and at the newly acquired Brett Arboretum at Fairfield, Conn.

St. Regis Awards Northeastern Scholarship

St. Regis Paper Co. has announced the award of its undergraduate scholarship in forestry in the northeastern United States for the academic year 1959-1960 to Lawrence O. Safford, a forestry student at the University of Maine, Orono, Maine.

Safford was chosen by a committee consisting of Hamilton K. Pyles, regional forester, U. S. Forest Service, Upper Darby, Pa.; Dr. Ralph Marquis, director, Northeastern Forest Experiment Station; and Paul M. Dunn, St. Regis director of forestry.

This award in the Northeast completes St. Regis' forestry scholarship program for the academic year 1959-1960. St. Regis annually awards five undergraduate scholarships in forestry —three in the South and one each in the Northeast and Northwest.

The Northwest award was made to Lawrence E. Goodman of Oregon State College and the Southern awards to George L. Perry of the University of Georgia; Claflin R. Garst, Jr., University of Florida; and Kenwood C. Nichols, Alabama Polytechnic Institute.

Ford Forestry Center Names Research Forester

William R. Beaufait has been appointed to the position of research forester at the Ford Forestry Center, Michigan College of Mining and Technology. He will conduct research in the silvics and silviculture of Upper Peninsula forest types.

Dr. Beaufait has received degrees from Wayne State University, the University of Minnesota and his Ph.D. from the University of Michigan. Prior to the present appointment he spent four years with the Southern Forest Experiment Station studying the silviculture of bottomland hardwoods and two years with the Michigan Department of Conservation investigating the use of prescribed fire for jack pine regeneration.

Redwood Region Conservation Council Awards Scholarship

Award of the first $500 College Forestry Scholarship of the Redwood Region Conservation Council to Ralph Brooks Sibley, student at Humboldt State College, Arcata, Calif., has been announced by William R. Schofield, California Forest Protective Assn., San Francisco, chairman of the RRCC Scholarship Award Committee. The scholarship was established last year as a phase of the RRCC's forest industry conservation education program.

Pulp and Paper Foundation, Inc. Scholarship Awards

Dr. H. Y. Charbonnier, Union Bag-Camp Corporation, Savannah, Ga., chairman of the Scholarship Committee of Pulp and Paper Foundation, Inc., has announced the award of $32,825 to 57 applicants enrolled in the pulp and paper technology program at North Carolina State College for the 1959-60 academic year.

Richard J. Preston, dean of State College's School of Forestry, presented the records of over 100 applicants to the committee for their consideration in selecting recipients for the scholarship awards.

Coal Co. Awards 25 SIU Scholarships

Twenty-five Sahara Coal Company scholarships, covering tuition and fees, were awarded to Southern Illinois University forestry students this fall, according to Neil Hosley, SIU forestry department chairman.

The awards are part of 60 scholarships provided by the coal company in 1957 for distribution over a four-year period to qualified SIU students.

Nineteen of the students will be entering freshmen, four have been approved to receive the award for the second year, and two are sophomores receiving scholarships for the first time.

SIU activated a four-year forestry program leading to a bachelor of science degree on January 1, 1958. The first degrees will be granted next June.

Hauss and Gulf States Paper Scholarships

Winners of the senior and sophomore Edward A. Hauss and sophomore Gulf States Paper Corporation forestry scholarships at The Alabama Polytechnic Institute have been announced.

Three senior awards of $500 and four sophomore awards of $400 each have been made. Recipients of the Edward A. Hauss senior scholarships are: James A. Buford, Jr., Charles E. Aylin, and James A. Dukes.

Those receiving Gulf States Paper Corporation scholarships are: Robert

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D. Allen, Jr., and Richard A. Mills. Philip Hodgkins, and William W. Sellers, received Edward A. Hauss sophomore awards.

5-Day Softwood Lumber Course

Michigan State University, East Lansing, Mich. announces a 5-day Softwood Lumber Course to be held on campus at Kellogg Center December 7-11, 1959, sponsored by the Department of Forest Products of M.S.U., with the cooperation of The Southern Pine Inspection Bureau, The West Coast Lumber Inspection Bureau, The Western Pine Association and The California Redwood Association.

Considerable emphasis will be placed on the grades, grading and use of southern pine and western and west coast softwoods, including redwood. It is further intended to broaden the knowledge of each man concerning wood itself.

There is no restriction on the number of men from any one company. Applications will be accepted in the order received—up to a maximum of 75.

Enrollment may be made by sending name and company name and address to Softwood Lumber Course, Continuing Education Service, Michigan State University, East Lansing, Mich. A check for $40 (per man), payable to Michigan State University, must accompany each application.

Lumber Seasoning Short Courses

Two sessions of a six-day course in lumber seasoning will be offered on the West Coast this fall, according to Fred E. Dickinson, director of the University of California Forest Products Laboratory, and L. D. Espenas, acting director of Forest Products Research at the Oregon Forest Research Center.

The first course will be held in Corvallis, Ore., beginning November 30, and the second in Richmond, Calif., beginning December 7.

The two courses will be similar in organization, content, and cost. The Pacific Southwest Forest and Range Experiment Station and the University of California School of Forestry are cooperating with the California laboratory, and the Pacific Northwest Forest and Range Experiment Station and the Oregon State College School of Forestry with the Oregon laboratory. The U. S. Forest Products Laboratory, Madison, Wisconsin, is cooperating with both organizations in providing course materials.

The course content is aimed primarily for the benefit of kiln operators, but personnel from management, supervisory, and sales staffs are encouraged to enroll.

Enrollments will be limited to 30 persons and applications will be accepted in the order received. Fee: $75 per person.

Application forms and additional information may be obtained by writing to the Department of Conferences and Special Activities, University Extension, 2441 Bancroft Way, Berkeley 4, Calif., regarding the course at Richmond, or to the Oregon Forest Research Center, P. O. Box 571, Corvallis, Ore., regarding the course in Corvallis.

Forestry Employment

S.A.F. members are privileged to insert one 60-word advertisement in this column without charge. Forest industries desiring to employ foresters may insert advertisements at the rate of $4 per column inch. Copy must be received by the end of this month for an advertisement to appear in the issue after next.

Obviously the Society cannot assume responsibility beyond making it possible for prospective employee and employer to enter into negotiations.

Positions Wanted

Forester, B.S., 1955, Univ. of Mass. Age 25, married. Experience: 3½ years U. S. Forest Service including timber cruising, management, scaling, appraisals, sales administration, fire protection, and wild life management; 2½ years (summers included) private construction companies — road and building construction. Desire employment in private industry with opportunity for advancement.
Box N, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, 35, married, 3 children, veteran, B.S., Michigan State, some graduate work. Employed by Government agency in Midwest 8 years; would like change. Experienced all phases land resource management, surveying, cruising, marking, planting, T.S.I., etc. Some shade tree and municipal forestry experience. Prefer Southwest, but good schools, medical facilities, opportunity, most important. Active in church, civic, fraternal affairs.
Box O, Journal of Forestry, Mills Building, Washington 6, D. C.

Engineer and Forester, B.S.F., M.F. Twelve years experience on West Coast in all phases of pine and fir logging. Familiar with road engineering and construction, federal timber contracts, timber appraisal, and the management of contract loggers. Desire position with future in industry or teaching. Prefer western location but will consider any reasonable offer.
Box R, Journal of Forestry, Mills Building, Washington 6, D. C.

Forester, B.S.F., 1947. Desires responsible position in forest management affording opportunity for advancement. Prefer South. Extensive experience in forest management with large pulp and paper company in Southeast.
Box S, Journal of Forestry, Mills Building, Washington 6, D. C.

Today's smallest two-way mobile radio - actual size!

New General Electric Transistorized Progress Line

General Electric's new Transistorized Progress Line will fit in more places, in more different positions, than any other two-way mobile radio you can buy today.

Not only is this the world's smallest, lightest commercial two-way mobile radio, but standby battery drain is so low you need never turn off your TPL mobile unit, just like the clock in your car. You install no special generator, use less gas, require fewer engine jobs.

TPL is the first two-way radio that transmits up to 75 watts of power in high band . . . the first that really fits under the dash . . . the first to realize the full benefits of transistorized design (no more than four tubes) . . . the first to eliminate bulky cables through new one-piece design of receiver control and transmitter . . . the first with shielded dirt-free ventilation.

The new General Electric TPL ushers in a new era of convenience and reliability in mobile communications. Don't miss all the exciting details. Write General Electric Company, Communication Products Department, Section 39119, Mountain View Road, Lynchburg, Virginia.

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"... so fast cutting and rugged"

Mr. C. F. Snell of Sedro Wooley, Washington, has been cutting timber on the West Coast for a good many years. He knows how important it is to have a chain saw that is dependable, easy to handle and easy to maintain . . . like the Homelite 7-19C.

Weighing only 19 pounds, less bar and chain, the direct drive 7-19C is light enough to carry *to* the job, easy to handle *on* the job. And it packs the kind of power a woodsman likes. Cuts through 8″ hardwood in 4 seconds, 18″ softwood in 12 seconds. Fells trees up to 5 feet in diameter.

Its famous Homelite short-stroke engine plus 7 other quality features let the 7-19C make your woodcutting more profitable and practical. See a free demonstration of the 7-19C at your nearby Homelite dealer's. Ask to see the other famous Homelite chain saws designed for production cutters.

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In Canada — Terry Machinery Co., Ltd.

As little as $4.55 weekly after small down payment

PROOF — In his letter, Mr. Snell has this to say: "I am pleased with the ease of handling the Homelite chain saw, and in my years of cutting here on the West Coast, I have never used a saw that is so fast cutting and rugged, yet so simple in design and easy to maintain — and oh so light that even a young lad can buck logs with it."

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- straight blades from 12″ to 30″
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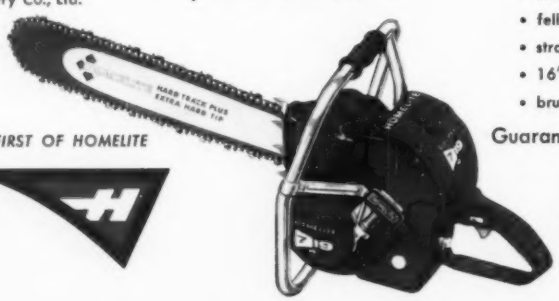

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